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PHOSPHORUS DEFICIENCY IN DAIRY COWS

ITS PREVALENCE IN SOUTH-WESTERN AUSTRALIA AND POSSIBLE METHODS OF CORRECTION

L. C. Snook, Animal Nutrition Officer.

DURING the past fifteen months an intensive investigation has been carried out to determine if nutritional deficiencies are in any way the cause of infertility in dairy cattle in the areas south of Busselton. Difficulty in getting cows stocked at the correct time has long been a problem, and the wastage through sterility is proving very costly to individual farmers. In co-operation with Veterinary Surgeon Harley, an effort has been made to find out if this seasonal infertility is a specific problem restricted to the areas in question, or whether it is merely a variant of one of the recognised forms of infertility now causing serious losses wherever dairying has become a major industry. These investigations are still in progress and will require much more detailed, controlled experimentation before authoritative statements can be made. At this stage, however, it is desired to report one of the findings because of its immediate practical implications.

In selected herds blood samples have been collected at monthly intervals for over a year. These samples have been analysed for a variety of constituents but only one abnormality has been detected, namely a persistent subnormal blood inorganic phosphorous. Persistent low values of the order found have always been taken to indicate phosphorous deficiency in the diet, which in turn may lead to ill-health, lowered milk production, sterility, and poor development of the young animals. But in the present investigation low blood phosphate levels have been found in a number of herds where the cows were producing well and appeared to be in excellent health. And of more importance, these subnormal values have been found not only during the summer months when the dry feed contains relatively little phosphate, but also throughout the winter months when abundant young green pasture of excellent quality was available. This raised the question as to whether the animals were indeed suffering any ill-effects from this commonly-seen subnormal blood inorganic phosphorus. To settle this point experiments are projected to determine just how much milk production, body growth, and fertility are influenced by the levels of phosphorous found in South-West herds. Meantime, however, it must be

accepted that while the blood is low in such an important constituent as phosphorus there will be a reduction in all-round efficiency. Because of this, tests were carried out to determine how to restore the blood phosphorus to normal, and how to do this with least expense and inconvenience. The result of these tests are recorded in this preliminary paper because they draw attention to a number of points of immediate practical importance.

Productive Dairy Cows Require Phosphatic Supplements All the Year.

This is an important fact which needs considerable emphasis. Farmers in this country have been advised by the Department of Agriculture about the dangers of phosphorus deficiency for many, many years. Ever since the classic work of Sir Arnold Theiler and his associates in South Africa it has been realised that, under our climatic conditions, cattle need phosphatic supplements during the long summer when dry mature herbage constitutes the bulk of the ration. Despite this Departmental advice, when this investigation was started very few dairy farmers were feeding any phosphatic supplement of any kind. During the war years such supplements had been difficult to procure and their use had necessarily ceased. Subsequently the farmers have tended to think that because they were now applying heavy annual topdressings of superphosphate to their pastures, and the establishment of perennials had greatly lengthened the period during which green feed was available, there was not the need now to supply additional phosphate to their stock in the form of mineral lick or bonemeal. Surely, it was assumed, the pasture itself would provide adequate phosphate to the grazing animal.

To check this assumption the author collected many pasture samples for analysis and the very important fact was established that, although the South-West mixed pastures were of excellent quality, being particularly rich in crude protein and total phosphorus, these pastures *at their best* could only supply enough phosphorus to satisfy the requirements of a cow producing between three and four gallons of milk per day. During the bulk of the year these pastures would do little better than satisfy the requirements of a two-gallon cow. A cow can eat only so much pasture per day and this "so much" will not meet the requirements of the heavy producer. As can be seen from Table I the pastures in the areas studied are of high nutritive value but it can be shown by calculation, using the standards set out by the Nutritional Research Council, U.S.A. (1946) and by Kellner (1926), that a dairy cow producing more than three gallons of milk will not be able to eat enough to satisfy her need for phosphorus. This explains why, in the herds being studied, the cows which calved at the

TABLE I.

COMPOSITION OF PASTURES, MARGARET RIVER AREA.
AVERAGE RESULTS.

Composition as a Percentage of the Dry Matter.

Date Collected	Number of samples	Description	Crude Protein	Crude Fat	Crude Fibre	Carbohydrate	Ash	Calcium as Ca	Phosphorus as P
August 1948	6	Green mixed pasture, grazed	25	3	21	40	11	0.9	0.35
October 1948	6	Green mixed pasture, grazed	22	4	22	44	8	1.0	0.32
November 1947	6	Good quality meadow hay	13	2	28	49	8	0.9	0.19
For Comparison. Typical British Pasture, grazed			20	4	20	46	10	1.0	0.3

beginning of winter with low blood phosphorus levels (and presumably low body reserves because of the dry feed during the summer) could not possibly milk well and at the same time "pick up," despite the excellent pasture. One of two things happened: the heavy producer depleted her body reserves in order to maintain production, or she produced less milk. In either case the farmer stood to lose, because obviously, if cows continue to rob their bodies to maintain production the general health and well-being must eventually suffer. Also important is the fact that if the cows become depleted during the winter they have no chance to build up while "dry" in the summer as the feed is then characteristically deficient in phosphorus. It could easily be that some such sequence as this explains the breakdown of many high producing cows. The need to supply phosphate to the good cow on good pasture seems to have escaped notice and should be given all the emphasis possible. With improved pastures the farmers are now keeping better cows. These better cows are the very ones which need the phosphatic supplement—while milking because milk is rich in phosphate, and while dry in order to replenish the skeleton and build up the developing foetus. The need for phosphatic supplements is obvious and steps were therefore taken, firstly to show that phosphatic supplements alone would restore the blood to normal and secondly to determine which supplement was the cheapest for extensive use.

The Effect of Sterilised Boneflour.

The first test was made with a well-known commercial phosphatic supplement in the form of sterilised boneflour. This was used to show that if depleted cows received a generous supplement, the blood phosphorus could quickly be restored to normal. In January, 1949, through the co-operation of a Cowaramup farmer, 20 cows were made available for the experiment. These were in the last month of their lactation and had shown low blood inorganic phosphorus levels throughout 1948. As can be seen from Table II, the deficiency was quite serious when the experiment began, the average value for blood inorganic phosphorous being only half normal. Twelve cows were then fed a supplement made up by mixing the boneflour (140 lb.) with bran (120 lb.) and coarse salt (180 lb.). This supplement was consumed in the bails at the rate of approximately one pound per head daily, this supplying about 20 grams of phosphorus (as P), or as much as that present in five oz. of commercial dicalcic phosphate. The remaining eight cows were used as controls. They ran with the test cows so that conditions were the same for all animals.

The results of the test are given in Table II. The supplement had a marked effect on the blood phosphate levels, the average for the test group doubling in a month that is, it increased from 2.5 mg. to 5.0 mg. per 100 ml. Some of the control cows also showed a marked increase in blood phosphorus, the average increase for the group being from 2.4 mg. to 3.9 mg. This increase was not unexpected, however, as the controls also consumed additional phosphorus. As before stated, the two groups of cows ran together, a desirable method of ensuring similar treatment, but it was found difficult to prevent the control cows from eating varying amounts of the supplement given to the test cows. Also it so happened that during the month of the test the pastures were topdressed with superphosphate and some of the control cows were seen eating lumps of superphosphate scattered among the dried herbage.

The results indicate, however, that, so long as additional supplies of phosphorus are made available to dairy cows, there is a quick improvement in the level of the blood inorganic phosphorus.

TABLE II.

EFFECT OF PHOSPHATIC SUPPLEMENT FED IN BAILS (COWARAMUP).

The supplement, a mixture of boneflour, bran and salt, contained 4.4 per cent. P, equivalent to 20 g. per pound.

SUPPLEMENTED GROUP: feeding commenced on 26/1/1949.

	Blood Inorganic Phosphorus—mg/100 ml.		
	7–12–48	25–1–49	28–2–49
Patches	2·7	1·9	4·0
Mollie	3·7	2·3	3·4
Trixie	2·7	2·3	4·7
Queeny	4·0	2·5	5·0
Jean	2·6	2·1	4·7
Biddy	2·4	4·5	4·9
Tiger	3·3	2·3	3·5
Susan	2·7	2·2	6·1
Minnie	4·0	2·0	6·1
Cherry I.	....	3·3	5·5
Rusty	....	2·6	6·6
Nora	....	1·9	5·9
	3·1	2·5	5·0

CONTROL GROUP.

	27–1–49	28–2–49
Sarah	2·7	3·5
Sally	1·9	2·6
Gypsy	2·0	3·2
Strawberry	2·7	4·0
Beauty	2·9	4·0
Brenda	2·2	4·7
Dorothy	2·6	5·7
Merle	1·8	3·2
	2·4	3·9

The cows in the control group were not supposed to receive any supplement but they were milked along with the test cows and took every opportunity to obtain the "lick." Some of the control cows were also seen eating superphosphate applied as top-dressing to the pastures.

Sodium Phosphate in the Drinking Water.

The next step was to show that it was the phosphorus in the supplement, which was the cause of the improvement, rather than some other substance supplied in the bran, or the salt, or the boneflour. Phosphate was therefore supplied to ten cows as pure sodium phosphate in the drinking water, the chemical being added at the rate of five pounds per hundred gallons of water. On the assumption that the cows consumed ten gallons of water per head per day this meant that each animal received about 18 grams of phosphorus per day (about as much as would be supplied by 6 oz. bonemeal). The water treated in this manner was consumed in normal

quantities, without any evidence of distaste. The effects produced by this supplement are recorded in Table III. The results indicate that the marked improvement produced by the feeding of the boneflour mixture could be maintained by the drinking of water treated with pure sodium phosphate. Also, that the treated water would effectively lift subnormal blood values to normal. In contrast, high values produced by the feeding of the boneflour quickly fell when the supplement was withdrawn.

TABLE III.

EFFECT PRODUCED BY SUPPLYING SODIUM PHOSPHATE IN THE DRINKING WATER.

GROUP I.

Cows receiving treated water after March, 1st. Ten gallons contained 18 grams of phosphorus as P.

Blood inorganic phosphorus in mg. per 100 ml.

	25–1–49	28–2–49	4–4–49	
Mollie	2·3	3·4	4·3	The improvement produced by the boneflour maintained by the treated water.
Trixie	2·3	4·7	4·9	
Biddy	4·5	4·9	4·8	
Minnie	2·0	6·1	5·2	
Merle	1·8	3·2	5·2	"Controls" from the previous month improved when placed on treated water.
Sally	1·9	2·6	7·1	
Strawberry	2·7	4·0	5·9	
Gipsy	2·0	3·2	5·4	
Cherry	....	....	5·3	Extra cows placed on treated water.
Daisy	....	....	6·7	
Average	2·4	4·0	5·5	

GROUP II.

Control cows on ordinary drinking water. No phosphate supplement after 28th Feb.

	25–1–49	28–2–49	4–4–49	
Patches	1·9	4·0	2·4	These cows all show decline in blood level when no longer receiving phosphatic supplement.
Queenie	2·5	5·0	3·2	
Jean	2·1	4·7	2·4	
Cherry I.	3·3	5·5	3·7	
Rusty	2·6	6·6	3·0	
Nora	1·9	5·9	3·2	
Sarah	2·7	3·5	3·2	
Beauty	2·9	4·0	3·0	
Dorothy	2·6	5·7	2·9	
Brenda	2·2	4·7	3·7	
Average	2·5	5·0	3·1	

The provision of phosphatic supplements through the drinking water has many advantages and the use of sodium phosphate in this manner has long been a standard practice in parts of the U.S.A. Unfortunately this compound is far too expensive for use in a like manner in this State, and a cheaper alternative had to be found.

Superphosphate as a Supplement.

In Table IV the relative costs of various phosphatic supplements have been recorded. It can be seen that superphosphate is easily the cheapest source of phosphate. In the past superphosphate has at various times been used for feeding to stock by mixing it with salt and molasses to make it palatable. But its use in this manner has never been encouraged, as about half the bulk of superphosphate consists ofgypsum which is quite useless to the animal, and it may also contain potentially dangerous amounts of fluoride. But there seems no reason why superphosphate

should not be used in the drinking water, as the gypsum and the calcium fluoride are both very insoluble and sink to the bottom in the form of a sludge. As bone-meal and boneflour are both in limited supply, and dicalcic phosphate is relatively expensive, tests were therefore made to see if superphosphate could be used in the drinking water to supply phosphate to cattle. The main trial was made on a property at Witchcliffe where the owner made some very thorough observations, using his herd of high producing Jerseys as test animals.

TABLE IV.

COST OF PHOSPHOROUS SUPPLIED IN VARIOUS SUPPLEMENTS

Retail Prices in Perth, April, 1949

	Cost	Percentage of Phosphorus as P	Cost per Unit of phosphorus
Superphosphate	£6 11s. per ton	8 per cent water soluble (18 per cent. P_2O_5)	9d.
Boneflour	24s. per 140 lb.	14 per cent. total	15d.
Bonemeal	15s. per 100 lb.	12 per cent. total	15d.
Dicalcic phosphate (concentrate)	36s. per 100 lb.	16 per cent. total	27d.
Dicalcic lick	22s. 9d. per 100 lb.	8 per cent. total	34d.

Infertility had become a very serious problem on this property. Blood samples were first taken early in December, the average blood inorganic phosphorus being only 3.4 mg. despite excellent green pastures, good milk production, and apparent freedom from disease. To correct this obvious phosphorus deficiency the liberal use of bone-meal was recommended and on 21st February, 1949, the use of superphosphate in the water was also suggested. Blood samples were again taken on March 1st by which time the average blood inorganic phosphorus had increased to 4.8 mg. per 100 ml. Just how much of this increase could be attributed to the use of bonemeal since December could not be judged, but from March 1st onwards no supplement other than superphosphate in the water was given. This was added to the water at the rate of 5 lbs. per 100 gallons. A control group of ten cows on similar pasture received only spring water. The results are recorded in Table V.

TABLE V.

USE OF SUPERPHOSPHATE IN DRINKING WATER OF DAIRY COWS. WITCHCLIFFE TEST COWS.

Blood inorganic Phosphorus—mg./100 ml.

Cow	Age	8–12–48 Cows producing well on excellent pasture	1–3–49 Bonemeal fed generously since middle December Superphosphate in water from 21–2–49	6–4–49 No Bonemeal or lick since 1–3–49 Super in water at rate of ½ lb. per cow per day
Maude	15	3·4	6·2	5·1
Lorna	15	2·4	4·2	4·6
Rene	12	2·3	4·5	4·7
Dainty	10	3·0	5·7	6·1
Hairs	9	3·7	4·6	5·2
Glad	5	4·0	4·3	5·3
Snow	5	4·2	4·7	4·7
Lankie	4	3·4	4·9	4·1
Rabbit	3	4·2	5·0	5·3
Tina	2	3·3	4·2	4·8
Average	....	3·4	4·8	5·0

CONTROL COWS.

Dry, on good pasture and normal water. No lick fed.

	6–4–49	
Night	4·4	Cows purchased in calf because insufficient could be bred on the property.
Trilby	3·0	
Pride	2·6	
Velvet	2·6	
Fauno	2·3	
Brownie	2·5	Cows bred on property; dry for a month or longer. Denise dry for 12 months.
Denise	3·9	
Spot	3·1	
Blondie	2·5	
Tot	3·6	
Average	3·0	

From this Table it is very apparent that the dry cows on normal summer grazing without any phosphatic supplement have subnormal blood phosphorus levels, whereas the ten cows on similar pasture but receiving approximately 18 grams of phosphorus per day in drinking water treated with superphosphate were able to improve or maintain the normal levels which resulted from supplements given before March.

Apparently the addition of superphosphate to the water produced similar improvement on other properties but the absence of controls makes comparison difficult. In a Karridale herd, for example, the highest average value for blood inorganic phosphorous seen in 1948 following the use of bonemeal was 4.4 mg. per 100 ml. whereas in 1949 after adding superphosphate to the drinking water for about two months the average value of ten cows (five recently calved, five near calving) on June 2nd was 6.0 mg.

Methods of Using Superphosphate in the Drinking Water.

The methods used to supply water treated with superphosphate will vary according to conditions. On the properties where the tests were made, stock are watered from concrete containers holding about 600 gallons, and filled by windmills. These large containers were treated by adding daily half a pound of superphosphate for every cow drinking from the trough on the assumption that cows drink about ten gallons of water per day. It would be more exact and foolproof, of course, to treat a container full of water by adding five lbs. superphosphate per 100 gallons, using this, refilling, and again treating with superphosphate. In the wheatbelt where the stock water is conserved in dams, it would be a simple matter to treat the dam in one operation at the beginning of summer so making certain that all stock drinking this water would be assured of an adequate phosphorus intake. Incidentally, the gypsum in the superphosphate will clear the suspended mud from water—treated water is always crystal clear. Some farmers are adding the superphosphate to the large tanks from which drinking water is reticulated. The necessary periodic removal of the gypsum from the bottom of the tank may prove difficult. Perhaps this could be avoided if the required amount of superphosphate is mixed with two or three times its weight of water (5 lb. superphosphate to one or two gallons) and left to settle. The clear supernatant fluid will contain most of the phosphate and this could be decanted into the tank, the useless sludge being thrown away. Doubtless many "tricks" and modifications will be used but there seems no obvious obstacle to the wide use of "superphosed" drinking water. This would permit all stock to build up their phosphate reserves during the summer months when normally the reserves of this mineral are being depleted. The possibility must even be considered that if the cows freshen in the autumn with adequate reserves there may be no need for further supplements while good quality green feed is available.

One possible disadvantage may be mentioned. The addition of phosphate to the drinking water encourages a prolific growth of green algae and similar water plants. This growth is not necessarily harmful but it may offend those who like to keep the water troughs clear of plant growth. Copper compounds readily kill these water plants and the occasional use of copperised superphosphate may eliminate the objectionable growth, where it is considered to be objectionable.

Use of Saturated Solutions of Phosphate in Feeding-Stuffs.

The treatment of drinking water has its limitations on properties where there is abundant free water, and of course has little application during the rainy months. A valuable suggestion made by Mr. R. B. Leiper of Cowaramup has therefore been developed and may prove of wide application. Mr. Leiper suggested that saturated solutions of water soluble phosphate should be used to damp down foodstuffs. Tests showed that the saturated solutions prepared by mixing superphosphate with water contained about 180 grams of phosphorus (as P) per gallon ; in other words a pint would supply as much phosphorus as 7 ounces of bonemeal. This means that the fluid is quite a rich source of phosphorus, and a number of farmers are testing out its value in practice by adding half-a-pint each day to the ration fed to their cows. No experimental data are yet available.

The preparation of the concentrated solution is very simple, superphosphate being thoroughly mixed with water at the rate of five pounds per gallon. On standing, the clear supernatant fluid can be dipped off as required, or decanted into another container. The residual insoluble material is discarded.

Although the saturated solution is strongly acid in reaction, it does not appear to be corrosive. Apparently a film of iron phosphate is formed on iron surfaces and this may be protective from, rather than inducive of, rusting. So far kerosene tins and galvanised buckets have been used at this Laboratory without apparent damage.

The Need for Further Experimental Work.

The data submitted in this report indicate that phosphorus deficiency is common among dairy cows in the South-West of this State. The preliminary experiments have shown that the subnormal blood inorganic phosphorus can be quickly restored to normal levels when phosphorus supplements are supplied in sufficient quantity. It remains to be shown, however, that this lift in blood phosphorus improves the health of the animals, the fertility, or the economic return to the dairy farmer. There seems no reason to doubt that the correction of an obvious blood deficiency will be beneficial and for this reason it seems that the results so far should receive publicity. Further studies are planned to follow up the interesting possibilities disclosed by this investigation.

Summary.

A preliminary report is made of observations which may prove of immediate interest to dairy farmers.

Analyses of blood samples drawn regularly over a period of fifteen months have shown that subnormal blood inorganic phosphorus levels are common in dairy cows in herds examined south of Busselton.

These subnormal values persist throughout the winter despite abundance of green mixed pasture of excellent quality.

These pastures have a better-than-average phosphorus content (0.28–0.40 per cent. P in the dry matter).

Attention is drawn to the probability that cows producing more than three gallons of milk per day cannot eat enough green herbage to satisfy their phosphorus requirements, even when the pasture is at its best.

For most of the year the herbage and meadow hay supply only enough phosphorus to meet the requirements of a two gallon cow.

It is thus apparent that phosphatic supplements must be fed *all the year* to dairy cows of any quality.

Commercial phosphatic supplements such as sterilised boneflour were found to restore the blood phosphate to normal, if fed in adequate amounts.

Pure sodium phosphate in the drinking water, at the rate of five pounds per 100 gallons, was equally effective in maintaining or restoring normal blood inorganic phosphate levels.

Because the usual phosphatic supplements are in short supply, or are expensive, the use of superphosphate in the drinking water was tested as a source of cheap, readily procurable, phosphate for direct supply to the animal.

Results are reported which indicate that superphosphate may be used in this way, five pounds of superphosphate being added to each hundred gallons of drinking water. Cows drinking ten gallons of such water receive as much phosphate as is present in six ounces of bonemeal.

Methods of supplying water treated with superphosphate are discussed. It is emphasised that the use of such water means that *all stock* receive an adequate phosphate intake during the summer months when reserves are normally depleted.

The possible use of saturated solutions prepared by thoroughly mixing five pounds of superphosphate per gallon of water, is discussed. These solutions could be used to damp down concentrates or hay.

Further experiments are planned, chiefly to determine if the restoration of normal blood inorganic phosphate levels is associated with any improvement in the health, production, fertility and growth rates of dairy cattle.

Acknowledgments.

The investigation, of which the results described in this paper form a part, was commenced in collaboration with Veterinary Surgeon Harley, who had stressed the seriousness of the problems involved and made arrangements for much of the field work. I must record my thanks to the many individual farmers who gave me help and information in the field. Particularly am I indebted to those who, month after month, at no small personal cost, have made their herds available for blood sampling and experimental work.

The routine analyses of pasture samples were carried out by the Government Chemical Laboratories.

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TREES FOR THE WHEAT BELT.

G. E. BROCKWAY, ASSISTANT CONSERVATOR FORESTS.

TO discuss the planting of trees on an extensive scale in an area such as the wheat belt of this State where there have been millions destroyed during the last half-century may seem somewhat strange. Nevertheless the planting of trees must play a large part in the future economy of our drier areas and will add to the comfort of people dwelling there.

It is obviously impossible to bring land under cultivation without clearing the natural vegetation. In the urgency of the clearing, little thought has been given to the problems which might arise as a result of this action. The uppermost thought in the settler's mind would more naturally be "when am I going to get my first crop ?" rather than " what effect will my farming methods have on the land by the time I am dead ? " From a purely personal point of view this may appear in order but nationally it can be catastrophic. Our national existence depends on our land and we cannot afford to have it ruined in a generation or two.

Mistakes of over-clearing have been made and are continuing to be made although many progressive farmers realise the necessity of repairing the damage wrought by themselves or their predecessors. There is much to repair. We have thousands of paddocks without a shade tree, thousands of farm buildings without a shelter belt, very many farmers with an inadequate firewood and timber supply and very few farms with an adequate system of wind-breaks. The stage is set for erosion on a large scale. The effects of wind erosion have already become apparent in many places in the form of partly buried fences and roads. Tree planting is not the full answer to this problem, but it is one of the several methods which, used conjointly, may effectually check it.

These are the more obvious results of indiscriminate clearing and are in many cases the result of lack of forethought. Another effect of clearing which could not be accurately forecast is the rise of the water table and the resulting rise of salt in many places.

It is not difficult to conclude that if you cut all the trees down in a district there won't be any shade trees left, but it would be practically impossible to say in absolute terms what the effect will be on the level of the water table or the salinity of the soil. While many settlers through lack of forethought destroyed valuable shade and shelter trees, others who have farmed light land have just not had any trees to destroy. Nevertheless, their need for trees is just as urgent or perhaps more so than that of the farmers on the heavier lands.

Much has still to be learned about the trees suitable for our wheat belt lands but considerable progress has been made and with the introduction of additional species able to withstand the climate of our dry areas this knowledge can be further increased very rapidly.

Our planting has up to the present time been confined to a very small list of trees such as the sugar gums, the pepper-trees (*Schinus molle* Linn), the kurrajong and more recently, the athel tree.

The sugar gum (*Eucalyptus cladocalyx*, F. Muell) is a splendid tree. It adapts itself to a wide range of sites and conditions but even so it has its limitations and may fail on shallow soils or soils which set very hard during the summer, particu-

larly in the drier portions of our wheat belt. It is easy to raise, a fast grower, of attractive appearance, but it is naturally a big tree and finds it difficult to reconcile itself to life under a telegraph line. "Tree pruners," do their best to keep it within due bounds and "sugars" planted in such circumscribed living room alternate between periods of stark ghastliness and beauty. We want other hardy street trees for our country towns.

The kurrajong is frequently a disappointment. Our own local tree (*Brachychiton Gregorii*, F. Muell) is certainly a drought resister but there has been difficulty in raising supplies of this in our coastal nursery. The introduced New South Wales kurrajong (*Brachychiton*), where it has succeeded, which is usually where it has enjoyed shelter and some extra water, has produced some excellent specimens but in the more exposed sites it is usually not a success.

The pepper-tree (*Schinus molle* Linn) does well in some sites, but in low lying clay situations where the soil bakes hard it seldom looks happy.

The athel tree (*Tamarix aphylla* Karst), a native of Northern Africa, has proved valuable on the better soils of our drier areas—particularly in the mining centres, both here and in the Eastern States. It has not yet been used extensively in the wheat belt—however it has the valuable property of being easily propagated from cuttings and if once established in a district its increase can be rapid and cheap.

With the development of a new Forests Department nursery at Kalgoorlie a new range of species is being made available the aim being to have a suitable tree for every site and every job and there appears little need to seek outside of Australia to find most of them. There seems little to be gained by even getting away from our own eucalypts which exhibit such outstanding variety of forms and shades of leaf colour, while some bear blossoms of very great beauty. Furthermore they possess that rather uncommon combination—fast initial growth and long life. Much as we might approve of the idea of planting for posterity, it is ever so much more gratifying if we have the satisfaction of enjoying the results of our labours as well.

As every farmer knows different soil types support different tree species—in fact it is not uncommon in farming circles for a soil to be described not by its physical and chemical properties but by the tree species which it originally carried.

There is a wide variety of soils in the wheat belt but some of the main broad groups are. :—

(a) The brown, red-brown and grey heavy soils originally timbered with trees such as salmon gum, gimlet, morrel and yorrel. These soils usually contain free lime and are alkaline in reaction.

(b) The brown and grey sandy or loamy surfaced soils originally carrying mallee. These soils often have alkaline clay subsoils with limestone nodules.

(c) The brown and red-brown medium textured soils with clay subsoils and which originally carried mostly york gum and jam. These soils have brown and red-brown clay subsoils usually without lime and are more or less neutral in reaction.

(d) The scrub plain and sandplain soils. These are grey to yellow in colour, sandy and often more or less gravelly. They are acid in reaction.

For the heavier and more alkaline soils of groups (a), (b) and (c) the range of suitable species includes some fine trees. The salmon gum and gimlet are well known but there are others of great promise, the most outstanding being Dundas Blackbutt

(*Eucalyptus Dundasi*) Dundas mahogany (*Euc. Brockwayi*) Merrit (*Euc. Flocktoniae*). and River Gum (*Euc. camaldulensis*). Planting carried out on heavy soils on the goldfields during the last three or four years with these and other species have given encouraging results.

Most of the trees suitable for the acid scrub plain soils will also grow on the better soils but the reverse is not necessarily the case. For the deep sands the sugar gum cannot be dismissed lightly but it has a number of possible companions and of these perhaps the most worthy of consideration are *Eucalyptus* Woodwardi, *E. camaldulensis* as large trees with several of the smaller trees or mallees to add variety, e.g. *E. Stoatei*, *E. Burracoppinensis* and *E. ebbanoesoensis*.

On the more gravelly portions of the scrub plains wherever the soil is shallow or tends to set hard the sugar gums are liable to fail and something hardier may fill the bill, possibly *E. Stricklandi* (if a tree with a shiny leaf is required), *E. torquata* (a good shade tree with beautiful blossoms) or *E. astringens* (a good shade tree producing a valuable tan bark and a fine tough timber.).

Saline Areas.—The tree with the greatest ability to stand up to salt appears to be *E. Sargenti* but observations of this species indicate that it is very subject to borer attack and other possible species which might be mentioned are *E. occidentalis*, *E. Brachycorys* and *E. gracilis*. *Casuarina glauca* cannot be left out of the list.

Sugar Gum (*E. cladocalyx*, F. Muell)

Methods of Direct Sowing.—While trees can be established by direct sowing (spot sowing) as is done in the Forests Department's mallet plantations, this method requires favourable conditions both from the point of view of soil and of climate. Moreover, plenty of seed is required. While this method has been found suitable in a 20 inch rainfall for the establishment of trees of one species at least (brown mallet) in plantations, it could not be recommended in the lighter rainfall areas or for such purposes as the establishment of windbreaks or avenues where the whole effect could be spoiled by failures in a few spots. Literature on tree establishment by this method is available from the Forests Department.

2. *Planting of trees obtained from the Nursery.*—Two methods are recommended :

(a) For establishment under field conditions where cultivation by farm machinery is possible.

(b) For establishment as isolated ornamental trees or in such situation e.g. in street planting where machine cultivation is not possible.

(a) *Establishment under field conditions.*

For some years a progressive farmer in the Narembeen district (average annual rainfall about 13 inches) has been establishing belts of trees by a particularly practical method similar to that used in the Victorian wheat areas although I understand that he arrived at it quite independently. This method entails briefly :—

(1) The ploughing and fallowing of the land for twelve months prior to planting.

(2) Fencing to exclude stock and rabbits.

(3) Planting during early winter (this differs from the Victorian practice of late winter or spring planting where tube grown trees are used instead of pot grown trees.

(4) Watering (about one gallon per tree) at the time of planting but no further watering subsequently.

(5) Cultivation between the rows shortly after planting and then at intervals for the next two years to keep surface free of weeds.

(6) The chipping of weeds from around the trees with a hoe where they cannot be reached by the cultivator.

(b) *Establishment of isolated trees, ornamental trees, street trees, etc.*

These cannot be given the cultivation recommended above and periodic watering is advisable for one or more years after planting.

Planting should be done in the early winter—preferably June but not later than August.

Positions for the trees should be selected where they will have ample room for development and will not be robbed by adjacent trees and shrubs. An area three or four feet in diameter should be cleared of all debris, worked to a depth of about eight inches and hollowed into a saucer shaped depression about five inches deep—in the centre of which the tree is planted. Where the ground is rocky it is sometimes found advisable to break it up with explosive.

Watering at the time for planting is advisable and thereafter at intervals as required. During the first summer watering once per week may be necessary but after this at less frequent intervals. Waterings should be heavy enough to ensure that the water soaks well down. Frequent light waterings which just moisten the top ultimately do more harm than good.

Furthermore, the planter must be prepared to take the requisite steps to ensure that there is no growth of weeds around the young tree. There is possibly no more frequent cause of loss than the over-running of the young trees by rank weed growth.

Details of Planting Methods.—Trees as received from the nursery are usually from nine to twelve inches high. A small healthy tree is to be preferred to a large spindly one which may put too much of a drain on the confined root system. When received trees have their roots enclosed in a cone of earth either in a pot or already removed from the pot. Trees should be examined as soon as they are received and if the soil in which they are established is at all dry, they should be watered. Watering should be closely attended to up till the time of planting. Many plants are received in good condition but are lost through drying out between the time the purchaser gets them and the time when he finds it convenient to plant them. If they are still in pots do not try to take them out without a thorough soaking. When thoroughly soaked the pots can be turned upside down and if the edge is sharply tapped on a rail or some other solid object, the earth will come away cleanly. Naturally the free hand must be held so as to support the cone of earth as it is freed from the pot.

Yorrel (*E. gracilis*)

Care is necessary to make sure that the cone of earth is not broken as most of our Eucalypts cannot stand having their roots damaged, but if as is often the case there is a coil of roots at the bottom of the cone these can be gently uncoiled and the planting hole deepened to take them.

It is advisable to be very sparing with manure at the time of planting. The native trees grow naturally in our soils without it. What manure, if any, is given should be well mixed with the soil and if of animal origin, should be well rotted before being applied. A mulch of grass, leaves or old rotted manure around the tree will check drying out.

Trees should be planted in damp soil so that the surface of the piece of soil in which they are received is covered to a depth of about one inch. Soil should be pressed around them to insure that all air pockets are removed and after pressing the soil loosely into place with the fingers a further pressing with the sole of the planter's boot, not too close to the tree, is advisable—after that watering should then be given.

If carefully planted in well prepared soil, the trees soon start to make new growth. Some planters endeavour to encourage rapid height growth by pruning off all of the side shoots. This usually results in a spindly plant which cannot support its own weight and requires continual tying up to supporting stake. It is advisable to prune as little as possible. The leaves constitute the food producing mechanism of the plant and their removal cuts down the food ration of the young tree. It will be found that as the tree develops the lower twigs having served their purpose of helping to feed the tree and protect the ground and young stem, will drop off in their own good time. If, when the tree is two or three feet high it is seen to have developed two main stems, one can permissibly be removed.

As most trees planted in the wheat belt will be in rather exposed situations and will lack the lateral protection enjoyed by trees growing under natural conditions, it is essential that they be allowed to develop sturdily to enable them to withstand heavy wind.

A slight variation in planting method is sometimes employed. This entails the holding of plants for twelve months in larger containers such as kerosene tins or old sanitary pans—instead of planting them direct into the soil when they are received from the nursery. For street planting in built up areas this method has much to commend it. At the end of this second year the trees should be four or five feet high. With careful planting and subsequent attention losses are negligible. While cases of theft and vandalism are not uncommon with small trees a few inches high, these larger trees provided they are protected by a guard do not suffer to the same extent.

In holding trees for this extra year certain precautions must be taken viz.,

(1) See that the containers have ample drainage holes –preferably at the bottom of the sides. By placing them thus the roots are less likely to get through into the soil below. If this should happen the cutting of the roots at planting time may prove fatal—some planters recommend that the bottom of the container be almost cut out—leaving a few small supporting strips which can be cut at planting time.

(2) As an additional precaution containers should be stood on supports a couple of inches high to prevent roots passing though into the soil below.

(3) To prevent the trees becoming too spindly, tins should be spaced about nine inches or a foot apart.

(4) Refrain from pruning except to correct a mis-shapen form or growth.

(5) Water at least two or three times a week. If allowed to become too dry, quite apart from the danger of losing the tree, there is a chance that through the shrinkage of the earth in the container, the next watering will run down between the container and the earth it contains and the tree will derive little benefit from it.

(6) At time of planting a hole deep enough to take the large block of earth in which the tree is established should be dug. The bottom should first be cut out of the container and the whole lot placed in the hole and then a cut put down the side of the container so that it can be removed.

(7) *Filling of the hole*—Watering and light tamping of the earth at time of planting as previously described is necessary.

Correct planting methods will be of little avail if the selection of species is unsatisfactory. Height, habit of growth and appearance are all factors to consider in relation to the purpose for which the trees are planted.

While Eucalypts are in most cases adaptable as to their soil requirements, it is advisable not to place too great a strain on their adaptability—but to plant trees from soil types similar to those to be planted. The Table at the end of this article should be referred to as a guide in these matters.

Spacing of trees.—An observer examining a thicket of gimlets which have grown up under natural conditions with close spacing will notice that very few, if any trees, possess a good shady crown. However a tree of the same species which has grown up in a more isolated position will usually be found to have a larger denser crown and incidentally to have attained a greater size than the more crowded specimens. This unfavourable effect of over-crowding is particularly marked under conditions where the amount of moisture available in the soil is small. The lesson is obvious ; don't plant trees too closely together, particularly those planted for shade or ornament.

Except in the case of the smaller trees, it is inadvisable to plant closer than about twenty feet apart, although if only one row of trees is planted, slightly closer spacing might be permissable as the tree roots can spread out on either side of the row.

One row of trees cannot be considered very effective as a wind-break under dry area conditions. The effectiveness of a wind-break, assuming it is in the right strategic position in relation to the area to be protected, depends on two main factors, viz., height and density.

Most of the trees which grow tall, have long slender trunks and a lot of wind can pass underneath them. It is advisable therefore to plant a row of more dwarf trees to take the first brunt of the prevailing wind and behind these one or two rows of the tall trees. The dwarf trees tend to break the force of the wind and deflect it in an upward direction and the taller trees behind continue this upward lift. *A good windbreak is considered to afford protection for a distance equivalent to ten times its own height.*

Something more than a strip of uncleared sand plain scrub is needed to protect an area of clearing.

Protection.—While protection from rabbits is necessary only for a couple of years, protection from domestic animals is required for a longer period. Cattle particularly may do considerable damage to trees while stock fed solely by hand on chaff and succulent green feed will frequently chew the bark from young succulent trees.

Above all, make certain that trees are protected from fire. This is the greatest enemy of our inland species and failure to take the required precautions in this direction may result in the death in a few minutes of trees which have taken years to establish.

Gimlet (*E. salubris*)

DESCRIPTION OF TREES RAISED (MOSTLY IN 3 in. POTS)

FORESTS DEPARTMENT, KALGOORLIE

Genus and Species	Height when Mature	Description	Purpose for which recommended	Soil requirements	Remarks
	feet				
Salmon Gum, *Eucalyptus salmonophloia*, F. Muell	80	Bark—smooth, salmon-coloured. Crown—umbrella, fairly dense. Leaves—small, bright green, shining. Blossoms—white, inconspicuous	Shade tree, avenue windbreak	Medium to heavy loam	Develops into splendid tree if not crowded.
Gimlet, *E. salubris*, F. Muell	40	Bark—smooth, bronze-coloured. Crown—umbrella. Leaves—small, shining, medium dark green. Blossoms—white, inconspicuous	Shade tree	Heavy loam	If planted too close trees become spindly.
Silver Gimlet, *E. campaspe*, S. Moore	35	Bark—smooth, bronze coloured. Crown—umbrella. Leaves—small, silvery-green. Blossoms—white, inconspicuous	Shade tree, street planting	Fairly adaptable, light to heavy loam	Good drought resistant.
Dundas Mahogany, *E. Brockwayi*, C. A. Gardn	80	Bark—smooth, pinkish-grey. Crown—fairly dense umbrella. Leaves long and dark green, shining. Blossoms—white, inconspicuous	Shade tree, windbreak	Medium loam	Similar to Salmon Gum but grows faster when young.
Dundas Blackbutt (Coffee Gum), *E. Dundasi*, Maiden	50	Bark—at butt dark and rough, limbs smooth and coppery. Crown—fairly dense. Leaves—dark green, shining. Blossoms—white, inconspicuous	Good shade tree, street tree or windbreak	Medium loam	Splendid all purpose tree.
Goldfields Blackbutt, *E. Le Souefii*, Maiden	40	Bark—rough at butt, smooth grey limbs. Crown—umbrella, generally slightly open. Leaves—mid-green, slight sheen. Blossoms—cream, inconspicuous	Shade tree for poorer soils	Sand or loam with or without gravel	Is often found in poor gravelly soils

Yellow-flowered Blackbutt, *E. Stricklandi*, Maiden	35	Bark—rough at butt, smooth grey limbs. Crown—in young trees pyramidal. Irregular on old trees. Leaves—long, leathery, dark green, shining. Blossoms—yellow, rather striking	Shade tree for poor soils	Laterite soils or loam	A good drought resistant, hardy tree.
Coral-flowered Gum, *E. torquata*, Luehm	35	Bark—dark, rough. Crown—fairly dense, globular. Leaves—small, dark, very little sheen. Blossoms—pink, rather striking, bright red calyx	Street tree, windbreak, shady and ornamental	Fairly adaptable, laterite or loams	Grown extensively at Broken Hill. Deservedly popular.
Merrit, *E. Flocktoniae*, Maiden	50	Bark—smooth, silvery-white. Crown—pyramidal. Leaves—small, very dark, shining. Blossoms—yellowish, pretty but not outstanding	Good general purpose tree	Sandy loam	Very ornamental tree, good for avenue planting
Boongul *E. transcontinentalis*, Maiden	50	Bark—smooth, silvery-white. Crown—umbrella but irregular. Leaves—Bluish-green, not shining. Blossoms—yellowish, pretty but not outstanding	Good general purpose tree	Sandy loam	Good hardy shade tree
Morrell, *E. longicornis*, F. Muell	70	Bark—rough grey. Crown—umbrella. Leaves—small, medium dark, shining. Blossoms—white, inconspicuous	Good shade tree	Medium to heavy loams	Good tree for planting on fluid soils near lakes.
Ribbon Gum, *E. brachycorys*, Blakely	40	Bark—smooth, silvery white. Crown—umbrella. Leaves—medium green, not much sheen. Blossoms—white, inconspicuous	Shade tree for lake country	Sandy loams, sand ridges near lakes	Fairly resistant to salt.
River Gum, *E. camaldulensis*, Dehn	60	Bark—smooth, white and greyish. Crown—branches droop somewhat. Leaves—pale green, not much sheen. Blossoms—white, inconspicuous	Good shade tree	Adaptable all loams	Good rapid-growing drought - resistant tree. May require supporting while young.
White Mallet, *E. falcata*, Turez	50	Bark—smooth white. Crown—rather bushy Leaves—mid-green, shining. Blossoms—inconspicuous	Good all purpose tree	Adaptable sandy loams, laterite, etc	
Brown Mallet, *E. astringens*, Maiden	....	Bark—smooth, bronze. Crown—rather bushy. Leaves—bluish, rather dull, small. Blossoms—inconspicuous	Good all purpose tree	Adaptable sandy loams, laterite, etc.	Produces mallet bark of commerce.

DESCRIPTION OF TREES RAISED (mostly in 3 in. pots)—*continued.*

Forests Department, Kalgoorlie—*continued.*

Genus and Species	Height when Mature	Description	Purpose for which recommended	Soil requirements	Remarks
	feet				
Blue Mallet, *E. Gardneri*, Maiden	....	Bark—smooth, greyish. Crown—rather bushy. Leaves—bluish-green, rather large. Blossoms—inconspicuous	Good all purpose tree	Adaptable sandy loams, laterite, etc.	
Pear Gum, *E. Stoatei*, C. A. Gardn	35	Bark—white grey, smooth. Crown—pyramidal. Leaves—dark green, small, leathery, Blossoms—yellow on large red calyx, striking	Ornamental	Adaptable sand to medium loam	Small ornamental symmetrical tree. Good for large garden, etc.
Wandoo, *E. redunca*, Schau *var. elata*, Benth	60	Bark—white and grey, smooth. Crown—umbrella. Leaves—bluish-green, rather dull. Blossoms—inconspicuous	Shade	Adaptable loam sand or laterites	
Lemon-flowered Gum, *E. Woodwardi*, Maiden	45	Bark—white, smooth. Crown—small branches droop. Leaves—pale blue-green with powdery white surface. Blossoms—rather beautiful, large, yellow	Ornamental	Deep loamy sand or loam	Hardy drought-resistant.
E. Kruseana, F. Muell	25	Bark—coppery, smooth but flaky. Crown—pyramidal later becoming irregular. Leaves—very small, sessile. Blossoms—yellowish-green—like bottle brush	Ornamental	Loamy sand and loams	Good for use as ornamental tree in garden
E. ebbanoensis, Maiden	30	Bark—smooth bronze-coloured. Crown—umbrella, rather dense. Leaves—medium green but black sheen. Blossom—white, inconspicuous	Good shade tree	Loamy sand	Hardy, drought resistant.
Yorrel, *E. gracilis*, F. Muell	40	Bark—rough at butt, limbs smooth coppery. Crown—bushy when not crowded. Leaves—dark green, shiny. Blossoms—white, inconspicuous	Street planting, shade tree, windbreak	Light and medium loams in lake country	Makes splendid shade tree and should be popular

E. intertexta, R. T. Baker	60	Bark—butt grey and rough, limbs smooth white. Crown—irregular. Leaves—bluish-green, rather dull.	Street planting, shade tree, wind-break	Sandy loams, etc. ...	A New South Wales tree. Very hardy. Rather like Boongul.
Sugar Gum, *E. cladocalyx*, F. Muell	70	Bark—greyish, smooth. Crown—rather bushy. Leaves—dark green, slight sheen. Blossoms—cream, inconspicuous	Good all purpose tree	Best in light soils provided they do not set hard in summer	Well-known tree. Not recommended below 16 inch rainfall.
Redwood, *E. oleosa* F. Muell	30	Bark—rough grey. Crown—umbrella. Leaves—dark green, fair sheen. Blossome—cream, inconspicuous	Shade tree	Light sandy loam....	Very hardy drought-resistant.
Flat-topped Yate, *E. occidentalis* Endl.	70	Bark—Rough and dark grey on trunk but smooth on limbs. Umbrella crown, leaves large and shining. Blossoms—yellowish white	Shade tree	Low lying sandy soils	Useful for swampy areas.
Salt River Gum, *E. Sargenti* Maiden	30	Bark—Rough and grey on trunk. On limbs, smooth or ribbony and brown in colour. Crown umbrella—leaves small and rather dull	Shade tree	Low lying salty situations	This tree is sometimes subject to borer attack.
Native Cypress or Native Pine (New South Wales), *Callitris glauca* (R.Br.) Mirb.	70	Bark—dark grey, rough and hard. Crown—pyramidal, leaves small and cypress-like, bluish-green in colour. Bears small cones, no flowers.	Ornamental	Deep loamy sand	Hardy, drought-resistant. Rather a slow-growing tree.
Native Willow, *Pittosporum phillyraeoides* D.C.	20	Bark—smooth, light grey, bushy top with drooping branchlets, leaves are dark green and narrow, flowers are small, white and inconspicuous. Seed capsules—bright orange coloured.	Ornamental. Good small shade tree	Sand to medium loam	Rather a slow-growing tree and only recommended for ornamental purposes.
Athel Tree, *Tamarix aphylla* Karst	50	Bark—dark grey, rough. Crown—bushy and dense leaves, small, rather like those of a sheoak. Flowers—cream in colour and rather inconspicuous	Ornamental, wind break, firewood	Adaptable as to soils, but appears to prefer the richer soils	Advisable to grow from cutting as once rooted it transplants badly. Hardy, drought-resistant, fast-grower.

COMMUNICATION BETWEEN HONEY BEES

R. S. Coleman—Acting Apiculturist.

An address given to the Bee-Keepers' section of the West Australian Farmers' Union the 12th July, 1949.

MOST of us, at sometime or another, have wondered if bees can communicate with each other and if they do, how much information they can pass on, but while we can make shrewd guesses there it ends. Fortunately there is a man who has and is still working with his considerable knowledge and intellect on this problem, and most of us have had contact with his work in some way or another.

This man's name is Prof. Karl von Frisch, an Austrian of the Graz University. He himself, with his co-workers, students and ex-students have given us information on many aspects of bee behaviour.

Firstly, he proved that bees can differentiate between the colours, which while guessed at before, had never been proved, the only exception being that bees are blind to red. The colours he used were blue, orange, yellow, green, violet and purple. (Ref. 1.)

Secondly, from his work was also discovered that bees may see colours beyond the range of the human eye; in other words they may be able to perceive infra red and ultra violet rays. (Ref. 1.)

Thirdly, Dr. Beling, an ex-student of Prof. von Frisch, found that bees have a time sense in that they will visit a spot at a certain time if they are used to being fed there at that time. (Ref. 1.)

Fourthly, Prof. von Frisch also discovered that bees have a taste sense, and he experimented with 34 sugars, 30 of which are sweet to us and nine proved sweet to the bees. (Ref. 1.)

Fifthly, Prof. von Frisch and his co-worker, G. A. Rosch, determined the duties of bees in relation to age—such as (in order of age) cell cleaning, feeding of older larvae, feeding of younger larvae, house-keeping duties, guard duties and field work. (Ref. 1.)

In 1920-23 Prof. von Frisch worked upon "Communication between Bees." He came to the conclusion that a dance, which he called the tail wagging dance, was an exhortation to neighbouring bees to go and collect pollen of the type which was in the dancing bees' "pollen baskets." Also he reported that the "round dance" was an exhortation for the other bees to go and collect nectar of the odour which the dancing bees exuded from their honey crops. These dances were proved to be used, only when new food was available, to get more gatherers for the job.

Prof. von Frisch was induced to resume his studies on "Communication between Honey Bees" in 1944 and from these experiments he discovered that he had made a mistake in the interpretation of his results in 1923 in that the "waggle" and "round" dances are not words in the bee language for different types of food but show the distance, direction, amount and kind of food to be picked up.

How he, step by step with repeated experiments, found and proved his deductions I will not trouble you, but his results and the language of the bees so explained are well worth relating.

Prof. von Frisch first found his own mistake in that he thought bees searched all the area around their hive, for either pollen or nectar, gradually spreading out. The reverse was found to be true. The bees, rather go to the spot where the food is to be found and spread out from there. This result made him realise the possibility of the bees giving an indication of the spot where food may be found, for he had eliminated the use of the scent organ to guide the bees. He then discovered that the waggle and round dances were indications of distances, not words meaning pollen and nectar.

In the round dance (Fig. 1) the bee dances clockwise and anti-clockwise in quick succession; the diameter of the circle is usually less than two cells and from a quarter of a circle up to two complete circuits may be danced before changing direction. The bees with this dance indicate that the food is close to the hive, saying in effect "look around near to the hive for the type of food I collected." As the distance to the feeding place increases, the round dance melts into the tail wagging dance.

FIG. 1

However, before going on, it is best that the tail wagging dance (Fig. 2) be explained first. In this the bee, from a point runs in a semi-circle and when opposite the starting point runs across the circle wagging the tip of her abdomen, she then runs around the opposite semi-circle, repeats the tail wagging run again and so on.

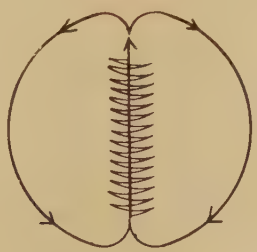


FIG. 2

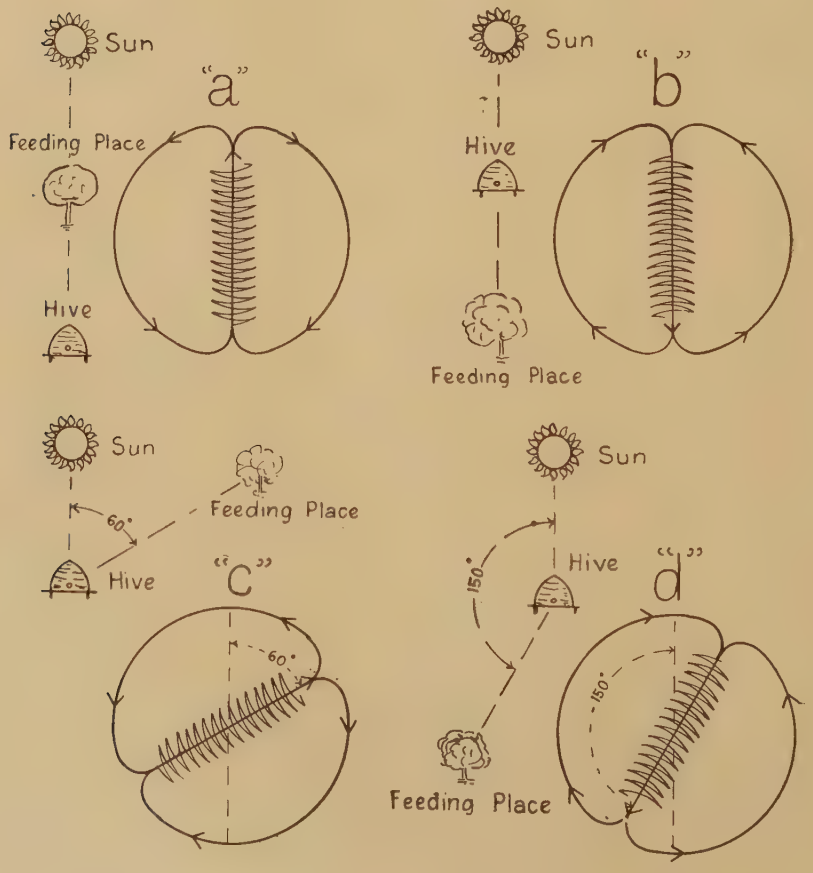
To go back to the story of the round dance. As the distance from the hive increases so do more of the tail wagging movements appear. Usually the first definite movement appears in the dance at 50 metres. Between 50 and 100 metres there is an almost complete change over. The bees at 100 metres

do a definite tail wagging dance, but occasionally a bee will interpose a complete circle. At 150 metres, a very occasional bee, will put a circle into her tail wagging dance. From 200 metres, however, only the wagging dance appears. On the discovery of this much, Prof. von Frisch reasoned that it was biologically improbable that the information passed from the dancing bee to her co-workers stopped at near to the hive and far away from the hive.

In 1945 he continued his experimenting and found that bees do communicate over 200 metres and still do to the limit of their flight range by the number of times the tip of the abdomen is moved in a run, or the length of time taken to make a complete run. The movement of the tip of the abdomen, is too fast for accurate counting with the human eye. A slow motion cine-camera would be the only answer. Therefore, time taken for a complete run was the only factor which could be measured by the professor. From his observations to give only two of many results Prof. von Frisch found that bees average seven to eight runs per 15 seconds with the feeding place at 200 metres and at 1,500 metres the bees average four runs per 15 seconds.

I believe the professor can with a stop watch in hand, gauge very accurately the distance a bee has returned with her load of nectar or pollen.

FIG. 3



The next problem which arose was the puzzle "did bees inform each other of the necessary direction to take to reach the food?" They could lay a scent track in the air, that seemed improbable but Prof. von Frisch by sealing the fifth and sixth segments together and by choice of location proved that the bees certainly had some other means of communicating direction to each other. The means of showing the direction of food proved to be the run of the waggle dance.

When resuming his experiments in 1945 Prof. von Frisch noticed that bees from a particular feeding spot always ran in the same direction and this direction changed during the day. The bees proved to be using the sun as a land mark for the others to steer by.

"The direction of the dance on a vertical comb bears a definite relation to the position of the sun. Thus a waggle dance upwards indicates that the food source lies in the direction of the sun. A waggle dance downwards indicates a feeding place in the opposite direction. A waggle dance to the right means that the food source is to be found to the right of the sun and at such an angle to the right by which the waggle dance deviates from the vertical. A waggle dance to the left indicates a feeding place at a corresponding angle to the left of the position of the sun."

The professor found this angle to be surprisingly accurate, very seldom out more than one degree and with the same result no matter which way the entrance is faced.

Another fact that is almost unexplainable—bees on the dullest days, with very thick clouds, can indicate direction relative to the sun as accurately as on the sunniest of days.

The next amazing thing, then discovered was that the bees can, without any pause, when the comb is turned to a horizontal position change from this business of indicating the direction in relation to the sun, to indicating the actual direction as if the bee herself had a compass in her body pointing towards the food.

So now we know how the bees communicate to each other about firstly, the kind of food by regurgitating nectar from their honey crop or dancing with pollen bag, which gives the odour of the flower.

Secondly, about the amount of food available in proportion to the number of collectors by the vigour of their dances.

Thirdly, the distance of the food from the hive is shown by the form of the dance.

Fourthly, direction is shown by the direction of the run in the tail wagging dance. Shown by round dance up to 50 metres, waggle dance from 100 metres and the length and speed of the runs of the waggle dance over 200 metres distance.

Prof. von Frisch is continuing his researches and I believe there is another paper, not yet to hand, showing how this knowledge about the language of bees can be used for leading bees to certain flowers when the more complete pollination and nectar-gathering will give an increase in an orchard crop or in a surplus of honey.

(This article, where not definitely shown, was subtracted from "The Bulletin of Animal Behaviour No. 5." by K. von Frisch, translated by W. H. Thorpe and Miss Erika Grossfield.)

Ref. (1) A.B.C. and X.Y.Z. of Beekeeping by A. I. Root.

STOCK FOODS.

The following Stock Foods have been registered at the Department of Agriculture under the Feeding Stuffs Act, 1928-46 for year commencing 1st July, 1949.

Stock Foods.	Reg. No.	Brand	By whom Registered	Materials from which Made	Registered Analysis							
					Crude Protein	Crude Fat	Crude Fibre	Sodium Chloride	Phosphoric Acid (P_2O_5)	Lime	Other	
					% (Min.)	% (Max.)	% (Max.)	% (Max.)	%	% Ca (Max.)		
1.—*Meat Meals.*												
Meat Meal	27	"COOGEE"....	Anchorage Butchers, Pty., Ltd.	Waste meat products	36·9	18·6	1·3	1·0	Max. 12·73	12·5	....	....
Meat Meal	29	WAME	The W.A. Meat Export Works	Meat, bone and blood	45·0	13·00	2·00	....	....	....	....	....
2.—*Meat and Bone Meals.*												
Meat and Bone Meal	18	EXCELSIOR....	Barrow Linton & Co.	Meat and bone	38·00	15·00	1·5	....	P_2O_5	....	....	....
Bone and Meat Meal	35	KITCHENS'	J. Kitchen & Sons, Pty., Ltd.	Animal Fat—bone	40·00	11·00	2·5	....	14·00	....	....	....
Protein Meat and Bone Meal	42	"CHAMPION"	SimsCooper (Aust.), Pty. Ltd.	Meat works offal	50·00	12·00	5·00	....	....	....	....	....
Meat and Bone Meal	125	TB & S (in diamond), No. 1	Thomas Borthwick & Sons (Aust.), Ltd.	Annimal offal	35·00	20·0	3·00	....	....	....	....	....
3.—*Blood Meals*												
Blood Meal	128	T B & S (in diamand)	Thomas Borthwick & Sons (Aust.), Ltd.	Animal blood	75·0	5·0	5·0	....	....	....	....	....
4.—*Fish Meals*												
Fish Meal	126	T B & S (in diamaond, No. 2	Thomas Borthwick & Sons (Aust.), Ltd.	Fish offal *ex* Processing Works	53·0	12·0	3·0	....	....	....	....	....
Do.	127	T B & S (in diamond, No. 1	Thomas Borthwick & Sons (Aust.), Ltd.	Fish offal *ex* Processing Works	38·0	15·0	3·0	....	....	....	....	....
5.—*Milk Foods*												Soluble Carbohydrates 43·9
Dried Buttermilk Powder	22	"SUNNY WEST	South West Co-op Dairy Farmers Ltd.	By product of butter manufacture	32·1	5·7	....	....	....	CaO	Lactose	
Krafco	24	KRAFCO	Kraft Walker Cheese Co., Pty., Ltd.	Prepared from whey derived from milk in manufacture of cheddar cheese	10·0	0·5	....	....	1·0	0·7	68·0	....

									Ca.		
6.—*Wheat and Wheat By-products*											
Wheat Meal	11	MILLERS	W. H. Milne & Co.	Crushed wheat	8·0	....	5·0	....	....	....	....	....
Sub-Bran	12	do.	do. do.	do. do.	8·0	....	9·0	....	....	....	....	....
Stock Meal	13	do.	do. do.	do. do.	8·0	....	9·0	....	....	....	....	....
Wheaten Meal....	56	"C" MEAL	W. Thomas & Co., (W.A.), Ltd.	Wheat	8·0	....	10·0	....	....	....	....	....
Do. do.	57	BRANATO	do. do. do.	do.	8·0	....	10·0	....	....	....	....	....
Do. do.	58	POLLATO	do. do. do.	do.	8·0	....	10·0	....	....	....	....	....
Roller Bran	104	WESFARMERS	Westralian Farmers Co-op Ltd.	Wheat	8·5	....	9·0	....	....	....	....	....
Wheat Meal	105	do.	do. do. do.	do.	8·5	1·0	3·0	....	....	....	....	....
7.—*Oil Seed Meals*												
Lin Meal	77	WESTERN	David Gray & Co., Pty., Ltd.	Linseed meal, yeast, malt, Bone meal, pollard, limestone	20·0	7·0	5·0	1·0	....	0·8	....	....
Pure Linseed Oil Meal	83	MEGGITTS	Elder Smith & Co., Ltd.	Pure linseed from which proportion of the oil has been extracted by mechanical pressure	30·0	4·0	10·0	....	....	....	....	....
A.—COMPOUND FOODS												
1.—*Protein Meals*												
Protein Concentrate	17	"EGGOLEEN"	Barrow Linton & Co.	Meat meal, cereals and minerals	37·5	Max. 12·0	1·5	6·0	....	4·0	....	....
Poultry Pusher	31	PANNIFEX	Wrights, Ltd.	Barley brannings, oats and rice brannings, pollard, bran, flax linseed, bols refuse, rape seed meal, bone and meat meal, blood meal, wheat polishings	32·0	Min. 7·0	8·0	Trace	..	Trace		....
Egg Milk	49	THOMAS	W. Thomas & Co., (W.A.), Ltd.	Butter milk powder, albumen milk powder, ground limestone, salt	18·0	5·0	4·0	3·5	....	15 ·0	....	....
Quick Lay	54	do.	do. do. do.	Meat meal, blood meal, liver meal, fish meal, milk powder, ground limestone, salt	35·0	Max. 12·5	4·0	6·0	....	15·0	....	....
Quickgrow	55	do.	do. do. do.	Meat meal, milk powder, ground limestone, salt	30·0	12·5	5·0	8·0	....	15 0	....	....
Protein Meal "A"	95	WESFARMERS	Westralian Farmers Co-op., Ltd.	Meat meal, butter milk, maize meal, fish meal, (when available), ground limestone, salt, manganese sulphate	35·0	Min. 8·0	4·0	2·5	....	4·0	....	....
Protein Meal "B"	96	do.	do. do. do.	Meat meal, bone meal, liver meal (when available), fish meal (when available), ground limestone	35·0	7·0	4·5	2·5	....	7·0	....	....
Westrade PVM	122	WESTRADE PVM	Westralian Trading Co.	Meat meal, peanut meal, sterilised bone flour, linseed meal, sorghum, rice and wheaten pollards, cocoanut meal	25·0	7·0	10·0	3·0	†6·0	....	.. .	....

† as Tricalcic phosphate.

STOCK FOODS—*continued.*

Stock Foods.	Reg. No.	Brand	By whom Registered	Materials from which Made	Registered Analysis							
					Crude Protein	Crude Fat	Crude Fibre	Sodium Chloride	Phosphoric Acid (P_2O_5)	Lime Ca	Other	
					% (Min.)	% (Min.)	% (Max.)	% (Max.)	%	% (Max.)		
2.—CATTLE FOODS												
Cow Food	14	"DAIRY FOOD"	Barrow Linton & Co.	Wheat, oats, barley, pea meal	9·0	2·5	6·0	....	....	....	....	....
Sweet Dairy Food	43	THOMAS	W. Thomas & Co., (W.A.), Ltd.	Bran, pollard, wheat meals, wheat germ, meat and liver meals, cocoanut meal and/or malt combings, molasses, limestone, salt	14·0	1·5	8·5	2·0	....	4·0	....	....
Sweet Dairy Food	75	WESTERN	David Gray & Co., Pty., Ltd.	Wheat meal, oat meal, barley meal, mill offal, linseed meal, flax meal, bone meal, yeast malt, limestone, salt	12·0	3·0	10·0	1·0	....	0·8	....	....
Sweetened Dairy Meal	99	WESFARMERS	Westralian Farmers Co-operative, Ltd.	(Wheat, oat, linseed and bone meals) clover pollard, molasses, ground limestone, salt, blue stone	11.0	2.5	6.0	1.0	....	1.0	Copper .003	....
2. *Calf Foods.*												
Calf Milk	52	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Butter milk powder, cocoanut meal, blood meal, pollard, ground limestone, salt	17.0	2.5	6.0	2.0	....	10.0	....	....
Calf Food	53	do.	do. do. do.	Linseed oil meal, meat meal, pollard, ground limestone, salt	20.0	2.5	8.0	3.0	....	10.0	....	....
Do.	66	VETAMAC	A. H. McDonald & Co.	Wheat pollard, maize meal, linseed meal, milk sugar, mutton bird oil	15.35	7.5	1.5	....	....	....	....	....
Do.	67	PARSONS	Parsons Bros. & Co. Pty., Ltd.	Wheat, oat branning, linseed, ground limestone, salt	12.0	2.0	6.0	....	....	....	....	....
Do.	76	WESTERN	David Gray & Co. Pty., Ltd.	Pollard, linseed meal, milk powder, yeast, malt, bone meal, limestone	20.0	7.0	5.0	1.0	....	0.8	....	....
Do.	82	HARPERS STAR	Robert Harper & Co.	Oats, linseed, maize, barley and rice meals, condiments	12.5	12.5	6.00	....	....	....	....	....
Calf Meal	100	WESFARMERS	Westralian Farmers Co-operative, Ltd.	Wheat, barley, maize, linseed and bone meals, butter milk*, whey powder, ground limestone, salt, copper sulphate	13.0	3.5	6.0	1.0	....	1.0	....	....
Calf Food	131	EVE-LYN	Tropical Traders, Ltd.....	Wheat, pollard, linseed (whole), salt, sugar, chalk, sulphur, tumeric, sodium bicarbonate, cream of tartar, founergreek, ginger, coriander, copper sulphate (trace), bole armenian	8.5	3.0	3.86	3.5	....	....	Sulphur 1.75	....

4. *Sheep Foods.*												
Maintenance Sheep Nuts	72	WESTERN	David Gray & Co. Pty., Ltd.	Linseed meal, yeast, malt, bone meal, wheat meal, salt, limestone, trace elements	15.0	3.0	7.0	1.0	....	0.8	....	....
Ewe and Lamb Nuts	74	do.	do. do. do.	Linseed meal, yeast, malt, bone meal, wheat meal, salt, limestone, trace elements, wheat germ	20.0	5.0	5.0	1.0	....	0.8	....	....
Sheep Breeder Cubes	101	WESFARMERS	Westralian Farmers Co-operative, Ltd.	Oat, wheat, barley, linseed, *peanut and *cocoanut meals, bone meal, clover pollard, molasses, limestone, salt, minerals	18.0	3.0	7.5	1.0	....	1.0	....	....
Sheep Maintenance Cubes	102	do.	do. do. do.	do. do. do.	14.0	3.0	7.5	1.0	....	1.0	....	....
4. *Poultry Foods.*												
Fattening Mash	7	MILLERS	W. H. Milne & Co.	Bran, pollard, wheatmeal grist, oats, meat meal, bone meal, salt	12.0	4.0	6.0	1.5	2.0	3.5	....	....
Laying Mash No. 1	8	do.	do. do.	Bran, pollard, wheat meal grist, oats, meat meal, bone meal, salt, limestone	14.0	4.0	5.5	1.5	2.0	3.0	....	....
Laying Mash	16	EGGLAYER	Barrow Linton & Co.	Bran, pollard, wheat meal, oat pollard, meat meal, salt, limestone	16.0	3.5	4.5	1.0	...	3.0	....	....
Fattening Mash	19	DUKKO	do. do.	Bran, pollard, wheat meal, oat pollard, bone meal, salt, limestone	10.0	4.0	4.0	1.0	....	3.0	....	....
Growing Mash	21	GROWELL	do. do.	Bran, pollard, wheat meal, oat pollard, meat meal, limestone salt, wheat germ	14.0	4.5	4.5	1.0	....	3.0	....	....
Poultry Mash	25	K.B.	C. A. Kirkby & Sons	Wheat, meat and bone meals, bran, pollard, salt, riboflavin, cocoanut meal	13.0	3.45	7.0	1.0	1.21	2.0	....	....
D Mash (Fattening)	36	MORLAY ...	Robert B. Young	Wheat meal, bran, pollard, bone meal, meat meal, minerals	10.5	3.0	5.0	1.5	....	4.0	....	....
Laying Allmash .. .	39	do. ...	do. do.	Wheat meal, bran, pollard, bone meal, meat meal, minerals, limestone	13.0	3.0	6.0	2.0	....	4.0	....	....
Growing Allmash	40	do.	do. do.	Wheat meal, bran, pollard, bone meal, meat meal, minerals, limestone, ribon	12.0	3.0	6.0	2.0	....	4.75	.. .	....
Growing Mash	41	do. . .	do. do.	do. do. do.	12.5	3.0	5.5	2.0	....	5.0	....	....
Laying Mash No. 1	44	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Bran, pollard, wheat germ, wheat meals, meat, blood and liver meals, milk powder, ground limestone, salt	16.0	2.5	6.0	1.5	....	3.75	....	....
Special Laying Mash	45	do.	do. do. do.	Bran, pollard, wheat meals, liver meal, ground limestone, salt	14.0	2.5	7.0	1.5	....	3.75	....	....
Fattening Mash	46	do.	do. do. do.	Bran, pollard, wheat germ, wheat meal, meat meal, pea meal, milk powder, ground limestone, salt	13.0	2.0	6.5	1.25	....	3.75	....	....
Laying Mash "B"	78	WESTERN	David Gray & Co. Pty., Ltd.	Mill offal, wheat meal, yeast, bone meal, linseed meal, limestone	12.5	2.5	5.0	....	....	0.8	....	....

*When available.

STOCK FOODS—*continued.*

Stock Foods.	Reg. No.	Brand	By whom Registered	Materials from which Made	Registered Analysis							
					Crude Protein	Crude Fat	Crude Fibre	Sodium Chloride	Phosphoric Acid (P_2O_5)	Lime Ca	Other	
					% (Min.)	% (Min.)	% (Max.)	% (Max.)	%	% (Max.)		
Laying Mash "A"	79	WESTERN	David Gray & Co. Pty., Ltd.	Mill offal, wheat meal, yeast, fish meal, meat meal, limestone	14.0	3.0	5.0	....	....	0.8	....	....
Laying Mash	84	MORLAY	Robert B. Young	Wheat meal, bran, pollard, meat meal, bone meal, ground limestone, minerals	14.0	3.0	5.5	2.0	....	4.0	....	....
Laying Pellets No. 2	87	RED COMB	Westralian Farmers Co-operative, Ltd.	Wheat meal, oat meal, pollard, bran, *buttermilk, salt, whey powder, ground limestone, *fish meal	11.0	3.0	7.0	1.0	....	1.0	....	....
Laying Pellets No. 1	88	do.	do. do. do.	Wheat meal, oat meal, pollard, bran, *butter milk, salt, whey powder, ground limestone, fish meal, meat meal	14.0	4.0	7.0	1.0	....	1.0	....	....
Growers Pellets	89	do.	do. do. do.	Wheat meal, oat meal, pollard, bran, *butter milk, salt, ground limestone, fishmeal, meat meal	13.0	4.0	7.5	1.0	....	1.0	....	....
Laying Mash No. 2	90	WESFARMERS	do. do. do.	Wheat meal, oat meal, pollard, bran, *butter milk, salt, whey powder, ground limestone	11.0	3.0	7.0	1.0	....	1.0	....	....
Laying Mash No. 1	91	do.	do. do. do.	Wheat meal, oat meal, pollard, bran, *butter milk, salt, whey powder, ground limestone, meat meal	14.0	4.0	7.0	1.0	....	1.0	....	....
Growers Mash	92	do.	do. do. do.	Wheat meal, oat meal, pollard, bran, *butter milk, salt, ground limestone, meat meal	13.0	4.0	7.5	1.0	....	1.0	....	....
Poultry Fattening Mash	97	do.	do. do. do.	Barley meal, wheat meal, pollard, bran, oat meal, salt, ground limestone,*buttermilk, *fishmeal	10.0	2.5	6.0	1.0	....	1.0	....	....
Poultry Fattening Pellets	98	RED COMB	do. do. do.	do. do. do.	10.0	2.5	6.0	1.0	....	1.0	....	....
6.—*Chickfoods.*												
Chickbuilder	9	MILLERS	W. H. Milne & Co.	Bran, pollard, wheat meal, cod liver oil, maize meal, bone meal, gristed oats, salt whey powder, oyster flour	15·0	4·0	5·5	1·5	2·0	3·0		
Chickstarter	10	do.	do. do.	(as above) and meatmeal	15·0	4·0	5·5	1·5	2·0	3·0		
Chickmash	15	VITALIZER	Barrow Linton & Co.....	Bran Pollard, wheat meal, oat Pollard, wheat germ, meat meal, milk powder, salt, ground limestone, oil	15·0	4·0	4·5	1·0	....	3·0		

Grain food	20	CHIC CHIC	do. do.	Wheat, oats, maize, peas	9·0	2·7	5·0	....	....	....		
Chickfood	23	W.A.P. APEX	W.A. Produce Co.	Wheat, maize, peas, oats shell-grit	10·0	3·0	6·5	....	....	....		
do.	32	H. & C.	Haynes & Clements	Wheat, maize, peas, grit	9·0	1·5	4·5	....	..	..		
Chickstarter	37	MORLAY	Robert B. Young	Wheat meal, bran, maize meal, meat meal, milk powder, ribon bone meal, vitamized oil, oyster grit, minerals	15·0	3·0	5·5	1·75	....	4·0	....	....
Chick Allmash	38	do.	do. do.	Wheat meal, bran, maize meal, meat meal, milk powder, ribon bone meal, oyster grit, minerals	12·5	3·0	6·0	1·75	....	4·0	....	....
Chicken Milk No. 1	50	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Milk powder, meat, liver, blood and bone meals, pollard, ground limestone, salt	25·0	1·5	4·0	3·0	....	15·0	....	....
Chicken Milk No. 2	51	do.	do. do.	Butter milk powder, albumen milk powder, bone meal, pollard, ground limestone, salt	20·0	1·5	4·0	3·0	....	15·0	....	....
Chicken Grain	59	do.	do. do.	Wheat, Maize, peas, shell grit	9·0	1·5	4·5	....	....	....	....	....
Chick Starter	61	do.	do. do.	Bran, pollard, wheat meal, wheat germ meat, fish, liver and blood, meals, milk powder, crayfish meal, cod liver oil, ground limestone, salt	18·0	2·5	6·0	1·0	....	3·75	....	....
Chickgrower	62	do.	do. do.	Bran, pollard, wheat meal, wheat germ, meat and liver meals, milk powder, crayfish meal, ground limestone, salt	14·5	2·5	6·0	1·25	..	3·75	....	....
Chickgrain	73	WESTERN	David Gray & Co. Pty., Ltd.	Maize, wheat, peas, oats, kalo, oyster grit	8·0	3·0	10·0	....	....	3·0	....	....
Chickstarter	80	do.	do. do.	Mill offal, maize meal, wheat meal, yeast, fish liver oil, limestone, milk powder, meat meal	14·0	4·0	5·0	....	....	0·8	....	....
Chick Builder	81	do.	do. do.	Mill offal, maize meal, wheat meal, yeast, fish liver oil, limestone, milk powder, meat meal, bone meal	13·5	4·0	5·0	....	....	0·8	....	....
Chick Mash "A"	85	WESFARMERS	Westralian Farmers Co-operative, Ltd.	Wheat meal, oaten, liver, maize and meat meals, pollard, bran *butter milk, ground limestone, manganese sulphate, salt, vitamised fish oil	15·0	4·0	7·0	Trace	....	Trace	....	....
Chick Pellets "A"	86	RED COMB	do. do.	do. do. do.	15·0	4·0	7·0	Trace	....	Trace	....	....
Chick Mash "B"	93	WESFARMERS	do. do.	Wheat meal, oaten, maize and meat meals, pollard, bran, *butter milk, ground limestone, salt vitamised fish oil	14·0	4·0	7·0	1·0	....	1·0	....	....
Chick Pellets "B"	94	RED COMB	do. do.	do. do. do.	14·0	4·0	7·0	1·0	....	1·0	....	....
Chick Food	124	ANCHOR	G. Wood Son & Co., Ltd.	Wheat, peas, barley, maize, crayfish meal, milk powder, oyster shell, bone meal, linseed	12·5	2·5	4·1	....	1·48	2·0	....	....
7.—*Pig Foods.*												
Pig Starter	47	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Bran, pollard, wheat meal, meat meal, bone meal, ground limestone, salt	12·0	2·5	6·5	2·0	....	4·0	....	....
Pig Grower	48	do.	do. do.	do. do. do.	12·0	2·5	6·5	2·0	....	4·0	....	..

* When available.

STOCK FOODS—*continued.*

Stock Foods.	Reg. No.	Brand	By whom Registered	Materials from which Made	Registered Analysis							
					Crude Protein	Crude Fat	Crude Fibre	Sodium Chloride	Phosphoric Acid (P_2O_5)	Lime Ca	Other	
					% (Min.)	% (Min.	% (Max.)	% (Max.)	%	% (Max.)		
H.—*Horse Foods.*											Sulphur (Max.)	
Horse Food	130	EVE-LYN	Tropical Traders, Ltd.	Pollard, linseed meal, linseed (whole), wheat, salt, chalk, magnesium sulphate, sulphur, sulphate of iron, copper sulphate, sodium bi-carbonate, medicinal herbs	8·5	3·0	7·0	6·5	0·9	1·75	2·5	....
9.—*Dog Foods.*												
Dog Biscuits	1	BOANS LOCAL	A. E. Robinson	Wheat, bone, meat, vegetable	15·0	4·0	3·0	....	2·5	2·5	....	....
Charcoal Shapes	2	SNAPS	do. do.	Wheat, bone, meat, vegetable and charcoal	14·0	3·0	6·0	....	2·5	2·5	....	....
Puppy Meal	3	do.	do. do.	Wheat, bone, meat, vegetable	15·0	4·0	2·0	....	3·5	4·0	....	....
Plain Shapes	4	do.	do. do.	do. do. do.	15·0	4·0	2·0	....	3·5	3·5	....	....
Puppy Biscuits	5	do.	do. do.	do. do. do.	15·0	4·0	2·0	....	3·5	4·0	....	....
No. 1 Dog Biscuits	6	do.	do. do.	do. do. do.	15·0	4·0	2·0	....	3·5	4·0	....	....
E.—STOCK LICK. 1.—*Mixed Stock Licks.*					Copper Sulphate	Iron Sulphate	Cobalt	Sulphur	Sodium Bi-carbonate			
Coast Compound	63	VETEMAC	A. H. McDonald & Co.	Pollard, iron sulphate, sodium bi-carbonate, sulphur, carbo-ligni, cobalt chloride, copper sulphate, aniseed, molasses	1·6	8·0	0·28	12·0	12·0	....	....	....
								Sodium Chloride	Phosphoric Acid P_2O_5	Lime CaO		Sulphur
Medicated Lick	64	do.	do. do.	Salt, sulphate of iron, sodium bi-carbonate, aloes, sulphur, magnesium sulphate, bone meal, molasses, potassium iodide, wheat meal	....	0·7	....	53·0	5·7	7·5	....	4·0
Mineral Concentrate	65	VETSOLICK	do. do.	Magnesium sulphate, sodium bicarbonate, carbo-ligni, pollard, sulphate of iron, sulphur, potassium iodide, bone meal	....	....	....	....	11·0	14·0	Iron 1·5	16·6
Di-Calcic Phosphate	68	C.S.M.L.	Cuming Smith & Mt. Lyell F.F., Ltd.	Calcium phosphate at least 90% of the P_2O_5 being as Di-calcic phosphate	....	....	....	....	37·00	28·0	....	....
Di-Calcic Lick	69	do.	do. do.	Di-calcic phosphate, molasses, salt	....	....	....	38·00	18·00	13·00	Molasses 5·0	....

Copper Lick	70	do.	do.	do.	Di-calcic phosphate, copper sulphate, salt	....	....	....	66·00	12·50	....	....	.... Vt. Fe
Denmark Lick Substitute	71	do.	do.	do.	Limonite, sulphate of copper, salt	....	....	....	38·00	....	....	....	20·00
Stock Lick	106	WESFARMERS	Westralian Farmers Co-operative, Ltd.		Salt, bone meal, bluestone, cobalt chloride manganese sulphate, iron sulphate	....	....	....	80·0	0·85	8·4	....	....
Lime Lick	107	do.	do.	do.	Salt, limestone	....	....	....	35·0	....	22·0	....	....
Di-calcic Lick	108	do.	do.	do.	Salt, di-calcic, phosphate	....	....	....	60·0	15·0	11·0	....	....
Denmark Lick Substitute	109	do.	do.	do.	Limonite, salt, copper sulphate	....	....	....	65·0	....	....	Iron 10·0	....
Kaf-o-vite	110	KAF-O-VITE ..	Goldsbrough Mort & Co., Ltd.		Rice, barley and linseed meals, wheat, pollard, bone charcoal, cane sugar and essence of aniseed	....	....	....	16·5	10·5	7·5	....	....
Cobaltised and Copperised Concentrated Sheep Lick "D"	111	VITA-LICK	do.	do.	Bone flour, bonecharcoal, sodium sulphate, sulphur, limonite potassium iodide, copper sulphate, cobalt chloride and meals from by-products of rice, cocoa and wheat	....	....	....	....	23·5	30·0	Min. Sulphur 2·0	Iron 1·3
Cobaltised and Copperised Concentrated Sheep Lick "G"	112	do.	do.	do.	Bone flour, bone charcoal, flowers of sulphur, limonite, potassium iodide, copper sulphate, cobalt chloride and meals from by-products of rice, cocoa and wheat	....	....	....	....	23·5	31·0	4·0	3·52
Cobaltised and Copperised Concentrated Sheep Lick Mixed "G"	113	do.	do.	do.	Bone flour, bone charcoal, sulphur, limonite, potassium iodide, copper sulphate, cobalt chloride, meals from by-products of rice, cocoa and wheat, and salt	....	....	....	80·0	3·8	4·9	0·64	0·56
Cobaltised and Copperised Concentrated Sheep Lick Mixed "D"	114	do.	do.	do.	Bone flour, bone charcoal, sodium sulphate, sulphur, limonite, potassium iodide, copper sulphate, cobalt chloride, meals from by-products of rice, cocoa and wheat and salt	....	....	....	80·0	3·7	4·7	0·32	0·18
Cobaltised and Copperised Concentrated Cattle Lick "D"	115	do.	do.	do.	Bone flour, bone charcoal, sodium sulphate, sulphur, potassium iodide, copper sulphate, cobalt chloride and meals from rice, cocoa and wheat	....	....	....	....	21·7	29·0	0·4	3·4
Cobaltised and Copperised Concentrated Cattle Lick "G"	116	do.	do.	do.	do. do. do.	....	....	....	....	25·0	32·5	1·15	4·7
Cobaltised and Copperised Cattle Lick Mixed "D"	117	do.	do.	do.	do. do. do.	....	....	....	75·0	4·2	5·4	0·08	0·64

Stock Foods.	Reg. No.	Brand	By whom Registered	Materials from which Made	Registered Analysis							
					Crude Protein	Crude Fat	Crude Fibre	Sodium Chloride	Phosphoric Acid (P_2O_5)	Lime CaO	Other	
					% (Min.)	% (Min.)	% (Max.)	% (Max.)	%	% (Max.)		
Cobaltised and Copperised Cattle Lick Mixed "G"	118	VITA-LICK	Goldsbrough, Mort & Co., Ltd.	Bone flour, bone charcoal, sodium sulphate, flowers of sulphur, potassium iodide, copper sulphate, cobalt chloride, meals from rice, cocoa and wheat, and salt	....	....	....	75·0	4·4	5·8	0·22	0·88
Vita Lick Mineral Mixture	119	V.M.M.	do. do.	Bone flour, bone charcoal, spanish iron oxide, ferrous sulphate, flowers of sulphur, sodium sulphate meals from rice and cocoanut, and salt	....	....	....	4·3	9·5	12·5	1·4	0·47
Chic-a-Vite	120	CHIC-A-VITE	do. do.	Bone flour, bone charcoal, ferrous sulphate, flowers of sulphur, sodium sulphate, gentian, cod liver oil, potassium iodide and by-products of rice	....	....	....	....	20·7	27·6	1·8	1·8
Por-co-Vite	121	POR-CO-VITE	do. do.	Bone flour, bone charcoal, sodium sulphate, flowers of sulphur, sodium chloride, limonite, calcium carbonate, copper sulphate, cobalt chloride, potassium iodide and cod liver oil	....	....	....	13·0	19·1	30·0	9·7	0·62
Salt Lick	129	LEPP	J. S. Corden & Co. (Vic.) Pty., Ltd.	Commercial salt	....	....	....	100·0	....	....	....	....
2.—Bone Meals.												
Sterilised Bone flour	26	TRI-CALOS	Davis Gelatine (Aust.) Pty., Ltd.	Bones	5·0	....	....	....	30·0	40·0	....	....
Bone Meal	28	ANCHO	Anchorage Butchers Pty., Ltd.	Waste meat products	23·63	2·44	....	Trace	26·76	26·95	....	....
Bone Meal	30	W.A.M.E.	The W.A. Meat Export Works	Bones	18·75	....	....	0·25	26·0	27·0	....	....
Bone Meal	60	THOMAS	W. Thomas & Co. (W.A.), Ltd.	Bones	10·0	....	....	....	20·0	25·0	....	....
Sterilised Bone Grit Meal	103	N.A.	Westralian Farmers Co-op., Ltd.	Bones	20·0	....	....	0·2	22·0	26·0	....	....
Bone Meal	123	F.P.L. All-Bone	Ferguson's Pty., Ltd.	Bones	18·0	....	....	1·0	27·0	34·0	....	....

NOOGOORA BURR—A NEW WEED MENACE

G. R. W. MEADLY, Weeds Officer.

Although a number of major weed problems exist in Western Australia, several of the more serious species of the other States, such as skeleton weed and mint weed are not known to occur here. Until a few months ago this same statement could have been made concerning Noogoora burr, but investigations following the initial discovery of burrs in a used sack at a Northam flour mill have disclosed the presence of this plant in several localities.

In March of this year Mr. G. C. Hadrill, having noticed some strange burrs in a sack, forwarded specimens for identification. These proved to be Noogoora burr, and a hurried visit to Northam disclosed that the bag, which had been held, contained more than 300 mature burrs. The bag markings showed that it had been used several times, once as a container for 5 lb. bags of self-raising flour prepared by a Queensland mill. The presence of some maize grains and a consignment marking indicated that it had been used for the transport of maize for stock food from Queensland to this State.

Widespread publicity was given to the discovery, resulting in many reports of suspected plants and burrs. Fortunately in most cases other plants had been confused with Noogoora burr, but some very helpful information was obtained and plants were located at Nedlands, Harvey, Fremantle and Morley Park. Further burrs were found in an old sack wrapped around a box of butter sent to Bowgada and they were also detected in sunflower, maize and kalo corn imported for parrot food. More recently a burr was submitted by a Dangin farmer who found it in straw packing around a stove purchased from a Perth store.

It is quite apparent that Noogoora burr can make its entrance through many doors. During a period of a few months the following media of introduction and distribution have been detected—

1. Maize imported for the preparation of stock foods.
2. Maize, sunflower and sorghum seeds brought from other States especially Queensland, for parrot food.
3. Used sacks.
4. Packing material including that used around shrubs.

The plants at Harvey and Fremantle undoubtedly originated from bird-cage refuse and guided the search in the direction of seeds imported for bird food. The Nedlands occurrence was traced with certainty to packing material around shrubs obtained from a Brisbane nursery. Burrs were found in some of this material used for mulching a shrub in the garden. In other States stock have been an important distributing agency. Although Bathurst burr has been found attached to animals arriving from the Eastern States, so far Noogoora burr has not been detected.

DESCRIPTION.

Noogoora burr is a spreading annual attaining a height of six to eight feet, but sometimes flowering and seeding when less than one foot high. The young stems are mottled and the somewhat roughened leaves are shaped as shown in the illustration. They are three to six inches broad and have a stalk varying from one to five inches in length. The inconspicuous flower heads are formed in clusters

close to the stem. The fruits (burrs), half an inch or somewhat more in length are terminated by two erect or slightly curved beaks. The burrs are straw to brown in colour when mature and each contains two flat seeds.

A plant of Noogoora burr in a Nedlands garden.

Showing foliage and some burrs.

SIGNIFICANCE AS A WEED.

It is generally accepted that this weed was first introduced to Australia at Noogoora Station, Queensland in the early sixties of last century, presumably as an impurity in imported cotton seed. Southern Europe and central Asia are regarded as being its natural habitat but it now occurs in many other countries. It now provides Queensland's No. 1 weed problem, infesting as it does the greater part of the sheep country in that State and seriously menacing the remainder. In recent years as much as 16 per cent. of the Queensland wool clip has contained the burr, representing a monetary loss of £¼ million in one season. On many properties it has been necessary to abandon sheep raising in favour of cattle.

Besides the loss in value of the clip which can be estimated, the debit against this weed must also include the reduced carrying capacity of infested areas along with the cost of control measures. Further, stock losses have been caused by eating this plant, especially in the seedling stage, no doubt due to the presence of a glucoside which has been isolated. .

Noogoora burr also presents a serious problem in Northern New South Wales, but is very limited in Victoria and South Australia and is not known to occur in Tasmania.

Burrs removed from the packing material shown on the left.

At a time when only a few plants have been found in Western Australia it is very interesting to recall the following statement concerning this weed made by Mr. J. H. Maiden when Government Botanist of New South Wales. "I was talking to Mr. F. M. Bailey, the Government Botanist of Queensland, a few days ago (this was written in 1896), about Noogoora burr. He said 'I well remember when £50 would have stamped it out in my colony; now it would take untold wealth to do it.'

"In 1899 I estimated that in New South Wales £1,000 judiciously spent would entirely free us from the pest: without any desire to be sensational, I stated that, if allowed to spread unchecked, it would in a few years deteriorate our territory to the value of a million of money. Today—1920—this is probably not very wide of the mark."

Noogoora burr.
The separate burr is somewhat larger than natural size.

PREVENTIVE ACTION.

As seeds, especially when imported for bird seed or stock food, have been the main means of introduction, action was taken immediately to ensure that all such lines were inspected upon arrival. The following proclamation was made under the Noxious Weeds Act:—

1. No person shall sell or dispose of stocks of maize, sunflower or sorghums or any mixtures containing these grains without the previous consent in writing of the Minister or an inspector first had and obtained.

2. No person shall import grains or seeds from any other State of Australia unless and until a certificate has been obtained from the Department of Agriculture of the exporting State to the effect that the grains and seeds imported are free from the following noxious weeds—Bathurst burr (Xanthium spinosum L.), Noogoora burr (Xanthium pungens Wallr.), Mint weed (Salvia reflexa Hornem.) and Thorn apples (Datura spp.) and at least seven

days prior to the arrival of the imported grains and seeds the Minister for Agriculture shall be notified of the intent to import such grains and seeds.

3. No person shall sell or dispose or otherwise make use of bags or any other containers of seeds and grains found to contain noxious weeds without the previous consent in writing of the Minister or an inspector first had and obtained.

4. The Minister or an inspector may destroy bags or any other containers found to contain noxious weeds where such bags or containers are being used or apparently kept ready for use.

All plants, including packing material, from other States, especially Queensland, are being subjected to a very close inspection, and the thorough examination of imported animals is being continued. The localities where plants have been found are being checked from time to time.

CONTROL MEASURES.

As yet only odd plants have been located and complete destruction by hoeing and burning has been possible. In cases where plants have shed mature burrs, as many as possible should be gathered and destroyed and a fire made on the affected ground. Each burr contains two seeds which seldom germinate at the same time and may retain their vitality for many years. Sites where plants have seeded should be kept under observation for a number of years, with a view to detecting delayed germination. Seedlings usually appear during the spring or early summer; warm moist conditions being conducive to germination. Spraying with 2, 4–D or hormone-like weed killers is an effective treatment and Queensland is embarking on large scale chemical operations.

It is probable that all Noogoora burr plants occurring in Western Australia have not been located. Early recognition of serious weeds is of primary importance in order that control measures may be taken before they become established. Any plant suspected of being Noogoora burr, or, for that matter, having the appearance of an undesirable weed should be sent to the Department of Agriculture for identification. If the plant is of little consequence no harm has been done, but if of major importance, serious loss to the State and individual farmers can be prevented.

ERRATA.

Journal of Agriculture, Volume XXVI. No 1. March, 1949.

Page 37, Table 2, last line for "13 13 3, 10.53, 5.02" substitute "14 0 6, 10.81, 5.15."

Page 38, Table 3, for "Guernsey (8 herds) 6,340, 51.12, 324.75, 13 19 11, 5.03, 10.34" substitute "Guernsey (8 herds), 6,340, 5.12, 324.75, 15 14 0, 5.49, 11.62."

Page 40, Table 5, line five of table for "5, N, D, Guernsey, 386.28, 5,470, 43 8 6, 4 11 2, 47 19 8, 10 2 6, 37 17 2, 6.29" substitute "5, N, D, Guernsey, 386.28, 5,470, 43 8 6, 4 11 2, 47 19 8, 21 13 6, 26 6 2, 13.5."

HORMEX TRIAL ON DOCKS AT DENMARK RESEARCH STATION.

By V. E. WESTON.

AN area of 48 square yards was selected in paddock 4 for this trial, with the following botanical analysis:—

	%
Docks	80
Wild Geranium	5
Clovers (Sub)	5
Rye Grass	10

The spray was applied when the docks were 12 inches to 18 inches and the remainder 8 inches to 9 inches high.

Hormex spray was diluted to $\frac{1}{8}$ pint of Hormex to $2\frac{1}{2}$ gallons of water giving 0.4 per cent. 2, 4– dichloro phenoxyacetic acid. One gallon of this mixture was sprayed as finely as possible over the 48 square yard area.

The plot was treated on 19/10/48 on a warm sultry day. The following day the docks had a greyish wilted appearance.

The following further observations were made:—

22/10/48—Docks showing burnt effect—leaves browning and drying up.

25/10/48—Docks considerably browned and withered—clover and geraniums also browning.

2/11/49—Docks shrivelled and stunted, clovers and geraniums browning and dying back.

20/11/49—Area 99 per cent. rye grass survival—showing much bare ground with browned and withered docks, clovers and geraniums. Eight stunted dock plants survived on the area.

A further spraying at the same rate was again applied after early autumn germination on April 20th, 1949.

This time the plot was treated when growth had reached a height of 8 inches to 9 inches. At this stage the botanical analysis had altered as follows:—

	%
Docks	50
Rye Grass	50

No clovers or other weeds were present.

The average number of dock plants per square yard was approximately 200.

The weather was fine and warm during and after treatment. At the end of seven days there was very little trace of Docks. By May 20th the area had a 99 per cent. coverage of healthy rye grass. Twelve dock plants survived this spraying. By August 20th, 1949, further germinations had increased the dock plants to three per square yard.

The results were most impressive and, providing 2, 4 – D can be obtained at a reasonable cost, old weed infested pastures could be rapidly improved.

The method of spraying could be improved also inasmuch as the equipment used in this trail did not produce a fine enough spray.

THE CUTTING OF SEED POTATOES

By E. T. Morgan, Chief Adviser—Vegetable Industry.

THE cutting of large potatoes to provide seed for the planting of the potato crop has for many years been a routine practice in Western Australia. This is particularly the case in respect to the planting of crops in the cool weather period approximately from June to October in each year.

It is customary to plant whole tubers, so-called "round seed" in the hot weather period generally in January and February.

This routine practice is, however, being varied and the use of cut seed is becoming more general in the irrigation areas even during the hot period when loss is likely to occur through the rotting of cut tubers.

It has been interesting to note the results of some experiments conducted at Cambridge (England) in relation to the cutting of potatoes for seed.

Investigations were made regarding the storage of cut sets including periods of time longer than a six-day maximum, which time had been allowed in previous experiments. The experiments showed that best results were obtained when planting took place immediately after cutting.

With cut "seed sized" tubers, the percentage of germination was 95.5 per cent. planted immediately after cutting and 84.5 per cent. after storage for thirty-four (34) days.

With cut "ware sized" tubers, the germination fell from 95.3 per cent. planted immediately after cutting to 76.7 per cent. planted thirteen (13) days after cutting, and 70 per cent. planted after thirty-four (34) days.

It is interesting to note that the loss in germination in the cutting of large potatoes was greater than when "seed sized" tubers were cut. Generally, the cutting of large potatoes results in large cut surfaces being exposed, whereas with smaller potatoes, so-called "splitters," the exposed surface is generally smaller and is therefore not calculated to be so liable to contract soil-borne diseases, to the extent that could be expected with larger unprotected surfaces, when planted.

From the experiments quoted the yields from plots decreased proportionately to the length of time that elapsed between cutting and planting. The most successful treatment for cut sets, from the standpoint of yield and plant establishment was the immediate planting after cutting.

The moisture and temperature conditions of the soil have been reported by American and Canadian workers as of great importance in influencing the incidence of rotting of cut tubers. Generally speaking, conditions in Great Britain are not inimical to freshly cut sets, but growers there are advised to use well healed cut sets for preference when soil conditions are bad.

In Western Australia conditions vary according to district and the time of planting. It is usual to find that crops planted in the period from May to August are sown on land that is either "new" or has not produced potatoes for a number of years. On such land the planting of cut seed has given little cause for concern and cut sets are sown immediately after cutting or within a few days of cutting, generally with good results.

On the other hand, planting in the summer period, November to February, is often done on land that has been continuously under potato cultivation for a number of years, and in many cases harmful soil organisms have evidently been built up to an extent that can prove harmful to cut tubers. Under such conditions the planting of freshly cut sets has often given disappointing results and the need for the cut surfaces to be calloused over prior to planting is emphasised. This healing process or suberising has been found to be satisfactory when cutting is done under moist conditions. When cutting has been done under dry conditions, however, callousing has not, in many instances, been satisfactory.

The wet bag treatment of cut seed potatoes has been advocated by the Department of Agriculture for many years and while old growers are quite familiar with the process, new growers may not be aware of it.

In order to take advantage of the fact that healing is satisfactory under moist conditions, the thorough wetting of the bags, into which the tubers are cut, allows of the necessary moisture for effective suberising of the cut surfaces. When a tuber is cut the suberin exuded from the cut surface combines with moisture to make a continuous layer over the surface which on drying forms a protective cover. For best results the bags should be well soaked prior to their being used as containers. It is good practice to cover the top of each bag when filled with another wetted one. The bags are then allowed to dry without further wetting. Where cutting is done into boxes they should be covered with wet bags until the cut surfaces have well calloused over. The seed should be kept in a cool sheltered position until required for planting.

From 24 to 48 hours are necessary to dry the cut surfaces of the tubers after which planting should be undertaken as soon as possible. From observations made in this State, it is not advisable to allow more than seven days to elapse following cutting before the sets are planted.

A further precaution during hot weather is to avoid, as far as possible, fertiliser coming into contact with the cut sets. If the sets are well pushed into the mould at the side of the turned furrow, and the fertiliser applied afterwards, little fear of fertiliser burn may be expected.

Another precaution, if planting takes place during heat wave conditions, which can often be expected in January and February, is to avoid the turning in of heated top soil on to cut tubers. If planting of cut seed is done in the early part of the day, following on with "round seed" during the hotter period, results should be satisfactory.

Quite a number of complaints in regard to faulty germination have come from the Manjimup district in recent years and it behoves growers to take all care in respect to the treatment and planting of cut seed. The wet bag method has proved more successful than where substances such as lime, sulphur, etc., have been used to dry cut surfaces of tubers.

LITERATURE CITED.

G. D. H. Bell, Ph.D., and H. W. Howard, Ph.D., "Seed Potato Cutting Experiments," Journal of the British Ministry of Agriculture, Vol. XLVIII, No 4.

POWDERY MILDEW OR OIDIUM OF GRAPES

W. P. CASS SMITH, Government Plant Pathologist
H. L. HARVEY, Assistant Plant Pathologist.

POWDERY mildew is the most common disease of grapes in Western Australia and occurs widely in commercial vineyards and home gardens. In seasons favourable for its development it causes considerable reduction in fruit yield and quality, especially when preventive and control measures are not rigidly applied.

Symptoms.

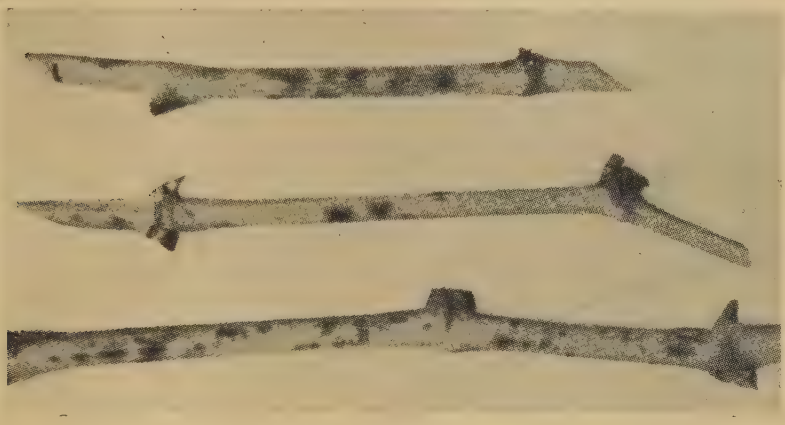
Powdery mildew is a fungus* which grows mainly on the surface rather than internally and is generally quite conspicuous as a dirty white powdery growth occurring as small or large patches on leaves, green canes and fruits.

**Oidium Tuckeri.*

Powdery mildew on vine leaf.
(*After Minis. Agric. Fisheries Advis. Leaflet* 207.)

Powdery mildew on grapes.
(*After Morwood.*)

It tends to rub off easily. When infection is heavy at flowering numbers of berries do not form and this results in a loose bunch rather than a well-developed compact one. The few berries that do set tend to remain small in size. Cracking of the berries may also result from mildew attack. When the mildew disappears later in the season a dark mark with a web-like pattern remains to indicate where it has been. These marks are often seen on leaves, berries and canes.



Dark marks on canes following mildew attack.
(*After Jacob.*)

Conditions favourable to the disease.

Humid weather with warm to hot conditions (75° to 95° Fahrenheit) favour the spread of the disease. Such conditions prevailed in the spring and summer months of 1947-48 when serious losses resulted in commercial vineyards. In home gardens conditions for the spread of mildew are brought about in most

Berries badly affected and cracked.
(*After Foëx.*)

seasons firstly by wetting vines with sprinklers, and secondly by encouraging the development of excessive foliage for shade and thus preventing adequate air circulation and the free entry of sunlight.

Losses in the 1947-48 season.

Weather conditions in the 1947-48 season were such that a rapid spread of oidium resulted and some commercial growers expressed dissatisfaction with the quality of dusting sulphur then being supplied compared with pre-war material. From a survey made at the time it was concluded that the high incidence of the disease was mainly due to (1) very favourable climatic conditions for disease development and (2) the absence of, or too late application of, control measures. Comparative freedom from the disease for several years had lulled many growers into a false sense of security. Tests carried out by the Government Chemist showed no deterioration in the quality of the ground dusting sulphur.

Oidium Control Experiment.

An experiment was arranged at Caversham on currant vines which are known to be susceptible to mildew attack, the purpose being to check the effectiveness of the ground dusting sulphur as used by growers during the last few seasons, and also explore the possibilities of six other fungicides (see Table 1).

The area under test consisted of some 256 vines. Three applications of the fungicides were made at approximately three to four weeks intervals, coinciding with the following growth stages, (a) when shoots were three to four inches long, (b) early blossoming, (c) after fruit set.

Sufficient spray was used to give a thorough wetting of the foliage and in the case of the sulphur dust sufficient to cover all green parts with a fine film.

Results.

The assessment of oidium up to picking showed that vines treated with sulphur dust were least damaged by the disease while a fair control was obtained by the other fungicides. The untreated vines were heavily infected

TABLE 1.

FRESH CURRANT YIELDS AND QUALITY.

(Average of Four Blocks.)

Treatment.	Yield.		Quality.
	Lbs. per three Vines.	Tons per acre.	
Sulphur Dust	109.5	6.5	Good
Colloidal Sulphur	95.5	5.7	Good
Colloidal Sulphur + Copper Oxychloride	87.0	5.2	Good
Colloidal Sulphur + Bordeaux mixture	85.5	5.1	Good
Zinc Copper Chromate	84.25	5.0	Good
Lime Sulphur	80.5	4.8	Medium
T.M.T.D.*	68.5	4.1	Poor
Untreated	40.75	2.4	Very poor
	P.05 = ±25.19 P.01 = ±34.29		

* Tetramethyl thiuram disulphide.

resulting in numerous withered and cracked fruits which reduced yield and quality considerably. Fresh fruit yields and quality taken at picking time reflected the superiority of sulphur dust in mildew control. These are shown in Table 1.

Recommendations for Control.

1. Dusting sulphur should be applied as a routine preventive measure at least three times, namely, when shoots are about four inches long, the second three weeks later and the third after fruit set. Further applications may be necessary if humid or showery weather develops later in the season. To avoid possible scorching of foliage in very hot weather early morning or late evening applications are desirable.

It is important in dusting to apply a fine but complete cover of sulphur to all green parts of the vine. This may be done by passing a good cloud of dust through the foliage.

2. Spraying sulphur (Colloidal sulphur) may be combined with Bordeaux mixture when the latter is used for anthracnose control. (Add 1¼ lb. to 40 gallons.)

3. Sanitation. Prunings and other vine debris such as withered or discarded bunches should be cleared from the vineyard and burnt as soon as possible.

PEDIGREE SEED PRODUCTION.

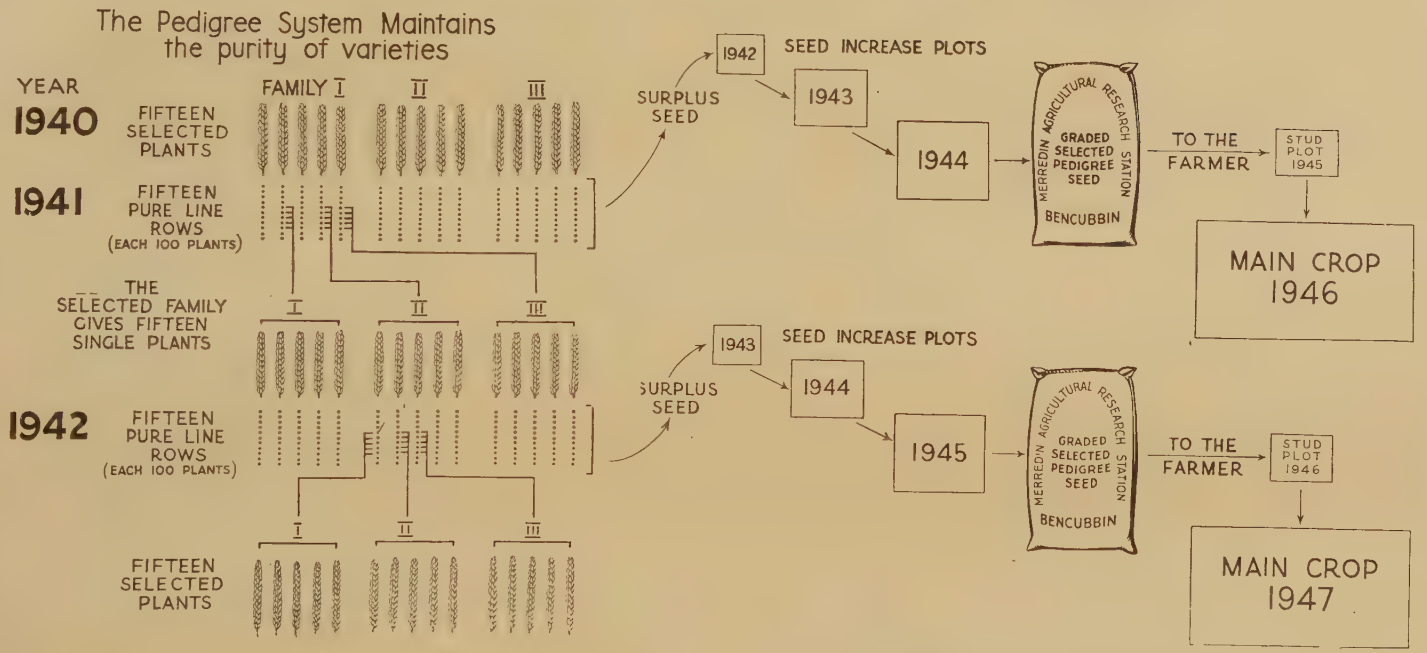
I. THOMAS, Superintendent of Wheat Farming.
H. G. CARISS, Agricultural Adviser.

IN the quest for higher yields the farmer is concerned with a number of sources of possible loss. When seed bed preparation and planting dates are satisfactory, the highest yields will be obtained from the best seed sample of the variety most suited to the district. The farmer is therefore concerned firstly with the choice of suitable varieties for his district and secondly with ensuring grain supplies of them for seed purposes.

The "pure line breeding" section of the Test Rows which serves to keep varieties breeding true for the varietal characteristics as the initial step in the production of pedigree seed.

To enable Farmers to obtain maximum yields from the standard and improved varieties

THE DEPARTMENT OF AGRICULTURE DISTRIBUTES
PURE GRADED PEDIGREE SEED



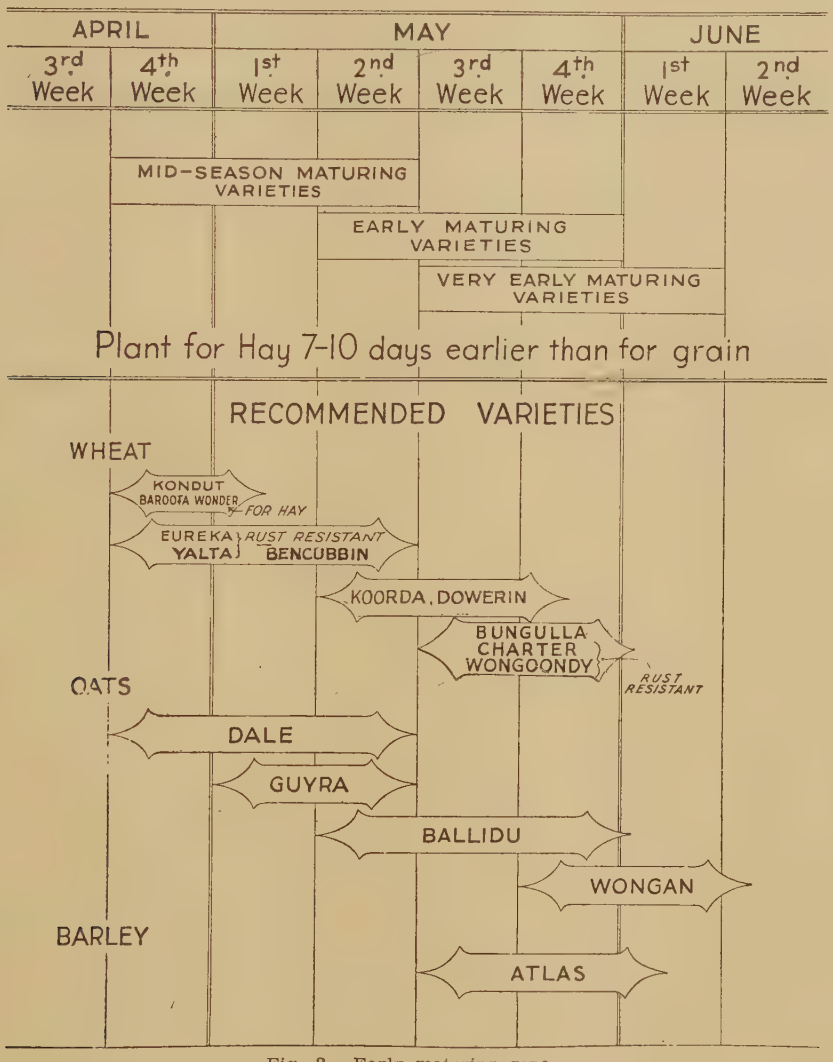


Fig. 2.—Early maturing zone.

For the 1947 seeding, twelve varieties accounted for over 90 per cent. of the acreage sown to wheat for all purposes in W.A., and 76 per cent. of the total was sown to the three leading varieties. W.A.-bred varieties accounted for two-thirds of the acreage sown.

The production of pedigree seed of the recommended cereal varieties has been a major function for many years of the agricultural research stations situated in the wheatbelt.

The Department of Agriculture is concerned firstly with producing new and improved varieties by crossbreeding and selection, and secondly with ensuring that supplies of pure seed of them are available to farmers. To maintain the variety so that it breeds "true" for the desirable superior characters, the Department maintains pure lines of the recommended cereals. The maintenance of pure line rows involves a pedigree system which immediately reveals any deviation from type.

The production of pedigree seed involves highly specialised work and the actual cost is relatively high when compared with commercial production of grain. At the Merredin and Wongan Hills Research Stations "pure line" breeding plots are conducted and it is from these plots that the actual seed obtained by the farmer is produced. The "pure line" rows are maintained by selecting each year the most prolific plants having the typical characteristics of the varieties concerned. The balance of the seed is planted in a larger block known as the "accumulation block" from which the seed is obtained for the planting of the "stud" plots at the various research stations, these in their turn providing the seed for the bulk plots from which the farmers' seed is supplied.

The surplus seed from the pedigree rows is increased each year until sufficient is available for distribution to the industry. (Fig. 1). The identity and therefore the pedigree of all seed is maintained during the years of increase. Many farmers ensure their supplies by buying each year sufficient pedigree seed

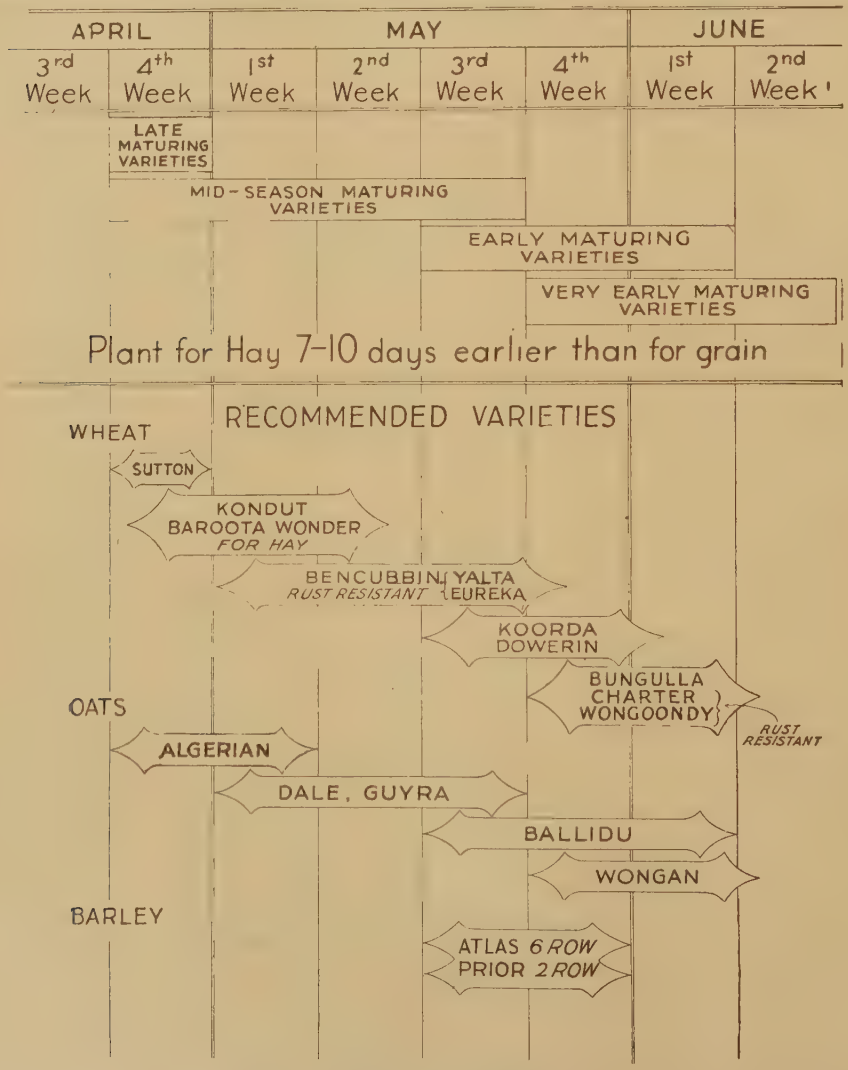


Fig. 3.—Midseason maturing zone.

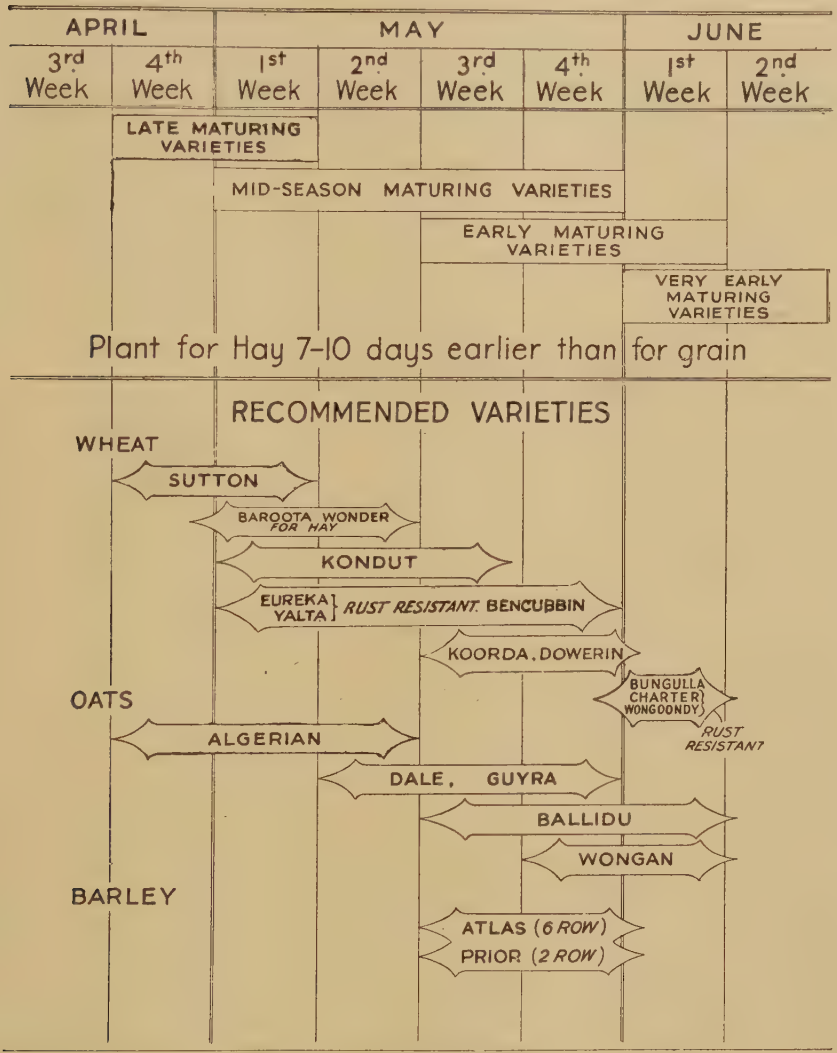


Fig. 4.—Late maturing zone.

from the Department of Agriculture for a small plot which is gradually built up until sufficient is available for planting the whole farm. This system enables the farmer, with appropriate care, to maintain his varieties free of admixture and therefore capable of giving the highest yields within the capacity of that variety.

It will thus be seen that the pedigree seed obtained by farmers is only four years away from the single selected plants. By adopting the method outlined above, it is possible to maintain the purity and high yielding capacity of the variety as it is not possible to have an admixture when single grain is used in the production of any one variety.

Numerous experiments have shown that the larger grains will yield more than smaller ones of the same variety. This indicates the desirability of grading seed if maximum yields are to be obtained and all seed distributed from the Research Stations is so treated.

In previous papers by Thomas, Millington and Cariss, 1944, 1947, the utilisation of the main cereal varieties was discussed. In those papers the wheatbelt was divided into three zones, according to the annual rainfall and for convenience, some of the tables and comments have been included herewith. The three zones and the road board districts included in each are:—

Zone 1.	*Zone* 2.	*Zone* 3.
Under 14 *in.*—	14-18 *in.*—	18-20 *in. and above*—
Mukinbudin	Northam	Greenough
Mullewa	Northampton	Irwin
Morawa	Upper Chapman	Moora
Perenjori	Geraldton	Victoria Plains
Dalwallinu	Mingenew	Toodyay
Dowerin	Three Springs	York
Wyalkatchem	Carnamah	Brookton
Koorda	Wongan-Ballidu	Cuballing
Mt. Marshall	Goomalling	Narrogin
Westonia	Meckering	Wagin
Nungarin	Corrigin	Katanning
Merredin	Kulin	Broomehill
Kellerberrin	Quairading	Tambellup
Kununoppin	Wickepin	Woodanilling
Bruce Rock	Dumbleyung	Esperance
Narembeen	Kent	(Southern 1/3)
Kondinin	Beverley	
Lake Grace	Pingelly	
Yilgarn	Gnowangerup	
Dundas	Esperance (Northern 2/3)	

In addition to obtaining a good sample of grain for seed purposes it is essential that each variety should be planted during the appropriate period for its maturity.

Seeding calendars have also been prepared for each zone covering the recommended varieties and their appropriate planting periods. (Figs. 2, 3, 4.)

It must be mentioned here that the indicated planting periods should be used as a guide with due regard to local conditions, as it will be appreciated that it is not possible to give specific recommendations for individual districts within a zone.

With all cereal plantings it is desirable that the seeding programme commence with the latest maturing variety being planted and be completed with the earlier maturing ones. For maximum yields it is not generally advisable to extend the planting periods for various maturities beyond those indicated. It is very desirable, however, that sufficient seed of both early and mid-season varieties be reserved and kept on hand in order that, if necessary, the areas sown to each can be adjusted to meet seasonal conditions.

With regard to the planting of cereals for green fodder (Cariss 1945), these are normally sown as early as possible in the season, irrespective of the maturity of the variety being used. In this connection the cereal varieties recommended are:—

Oats:

Algerian.—Late maturing (high rainfall areas particularly).
Dale.—Mid-season maturing.
Fulghum.—Mid-season maturing (standard grazing oat).
Ballidu.—Early maturing.
Wongan.—Very early maturing.

Barley:

Atlas.—Early maturing (very satisfactory).

For distribution from the 1949-50 harvest it is anticipated that pedigree seed of nine varieties of wheat, six of oats and three of barley will be available. Short descriptions of these varieties are:—

WHEAT VARIETIES.

With regard to maturity standards it is customary in Western Australia to classify wheat varieties into four standard maturity groups relative to the control variety, Gluyas Early:—

(i) Very early maturing—flowering five or more days earlier than Gluyas Early.

(ii) Early maturing—flowering four days earlier to three days later than Gluyas Early.

(iii) Mid-season maturing—flowering four to nine days later than Gluyas Early.

(iv) Late and late mid-season—flowering ten or more days later than Gluyas Early.

The following are short descriptions of the recommended varieties which are at present being produced as pedigree seed:—

Mid-season Varieties.

Kondut.—Bred at the Wongan Hills Light Lands Research Station, Kondut, has yielded well, over a wide range of soil and climatic conditions.

Although not rust resistant, it gives better yields under epidemic conditions than Bencubbin and Nabawa. It is resistant to flag smut.

The straw is stout and the variety can be recommended for early planting, particularly on light land and in rust liable districts.

Kondut yields flour which is usually superior in strength to that of the f.a.q.

Eureka.—This variety was bred by the New South Wales Department of Agriculture, and released as a resistant wheat for planting in rust liable areas. In 1941 a new race of rust was isolated in Northern New South Wales, capable of attacking Eureka, and this race, designated 126B, has now become the most prevalent race in Queensland, New South Wales, Victoria and South Australia, and Eureka and its derivative varieties can no longer be regarded as rust resistant in those States. Race 126B (previously designated Race 34 Biotype) has not yet been definitely isolated in Western Australia, and Eureka can still be regarded as a resistant variety in this State.

Eureka is a stout strawed rather tall growing brown chaffed variety with translucent grain. Under slow ripening conditions the grain frequently mottles. The flour strength of Eureka is well above the f.a.q. of the State. It is resistant to flag smut. The desirable planting date for Eureka in each district would be about the same as for Bencubbin.

Bencubbin.—The standard mid-season wheat which is the most extensively grown variety in Western Australia and also Australia. The straw strength tends to be weak on light land but is satisfactory for hay. Bencubbin is notable for its high yields under inferior seasonal conditions, and although very susceptible to rust is resistant to flag smut. Its flour strength is equal to the State f.a.q.

Yalta.—This midseason maturing variety was bred by the New South Wales Department of Agriculture as a rust resistant variety, obtaining its resistance from Kenya C6042. However in 1948 at least two new races of rust were isolated in Northern New South Wales capable of attacking all varieties deriving their resistance from this source. (Thomas, 1948). This variety is resistant to 126 and 126B, and can still be regarded as a resistant variety in Western Australia until such time as the new races are recorded here. The straw is of medium height, stands well and the baking quality of the grain is in the premium class. It is highly resistant, but not immune to flag smut. The results of trials to date confirm the opinion that the variety will be a very suitable one for replacing Eureka as a mid-season variety.

Dowerin.—This variety was selected at the Merredin Research Station from a cross between Sword and Kenya C6041. It is resistant to all known races of stem rust in Australia, and is the only registered released variety which derives its resistance from this particular Kenya parent. An early mid-season maturing variety it is tall growing with fine straw and a tendency to weakness under certain conditions. The grain quality is in the upper range of the f.a.q. It is resistant to flag smut and powdery mildew and has yielded well under trial particularly in the higher rainfall areas to which it seems to be most suited.

Early Maturing.

Koorda.—A relatively recent release by the West Australian Department of Agriculture, Koorda has yielded well on the lighter soils where its strong straw is of great value. Koorda is practically immune to flag smut and tends to be rust escaping in all but the heaviest epidemics. The flour strength of Koorda is about the same as that of the f.a.q. standard.

In yield trials on the Research Stations, Koorda has out-yielded Merredin a variety which it has been designed to replace.

Wongoondy.—This variety which was selected at the Merredin Research Station from a cross between Eureka and Bungulla is an early maturing variety which under suitable conditions produces grain approaching premium quality. It is a medium tall growing variety with a straw of excellent standing ability and holds it grain well. It is highly resistant to Race 126 of stem rust (previously designated Race 34) but, like its Eureka parent, is susceptible to Race 126B. This variety gives excellent promise and is favoured for its straw strength, earliness, prolificacy and its satisfactory grain quality.

Very Early Maturing.

Bungulla.—The standard early maturing variety and a selection from Bencubbin. Like Bencubbin is notable for its high yields, particularly under low rainfall conditions.

Because of its early maturity, it usually suffers relatively little rust damage. The straw strength is satisfactory on the heavier soil types, but Koorda is to be preferred on light soils in all but the drier districts.

Bungulla is satisfactory for hay whilst the flour strength is equal to the f.a.q. of the State. It is resistant to flag smut but not to rust.

Hay Variety.

The variety Baroota Wonder is grown almost exclusively for hay. It is a relatively tall growing wheat and remains green to the base until haycutting time. It is very susceptible to loose smut and rust, but moderately resistant to flag smut.

OAT VARIETIES.

Oats are notoriously difficult crops to harvest for grain, particularly following adverse weather conditions, and plant breeders therefore, have been particularly concerned with straw strength and non-shedding. The W.A.-bred oat varieties, Dale, Ballidu and Wongan, represent a notable achievement in respect to improved straw strength and ability to withstand unfavourable weather. These three varieties are selections made by Mr. D. R. Bateman at the Wongan Hills Research Station from a Mulga-Burt's Early cross and they fulfil the requirements of a general purpose oat. They are suitable for grain and hay and also for early green grazing and recovery. With their differing maturities they cover the range of the planting season.

Oats are classified as to maturity in much the same manner as are wheats:—

Very Early Maturing: Flowering four or more days earlier than Mulga.

Early Maturing: Three days earlier to six days later than Mulga.

Mid-season Maturing: Seven to fourteen days later than Mulga.

Late Maturing: Fifteen or more days after Mulga.

Oats are being increasingly used as a source of early green feed. They are sown either on fallow or stubble land in early April and fed off six to eight weeks after the opening rain of the season. Varieties vary considerably in their suitability for this purpose both in respect to the quantity of green feed produced and in their ability to recover after grazing.

Oats are used extensively for hay for which purpose the leading varieties are well suited. The present oat breeding programme aims at the development of varieties combining large grain size and straw strength and the retention of the long juvenile phase of Fulghum in a stronger strawed variety.

The following are short descriptions of the recommended varieties which are at present being produced as pedigree seed:—

Late Maturing.

Algerian.—The standard late general purpose oat which is cultivated chiefly in the Great Southern areas of the wheat belt, and the higher rainfall districts of the State. It is also used extensively for oatmeal manufacture.

Mid-season Maturing.

Guyra.—The standard mid-season variety which is notable chiefly for its plump grain. Although a popular hay variety the straw tends to be very coarse under favourable conditions of growth and lodging frequently occurs where crops are left for grain. Guyra is an indifferent variety for grazing and recovery since the early growth is relatively sparse and the grain yields, subsequent to grazing, only fair.

Fulghum.—The standard grazing and recovery oat, but is not a good general purpose variety as the straw strength is very poor. Fulghum is used principally for grazing and recovery since the notable length of its leafy growth phase prior to "shooting" enables it to be grazed later in the reason than other mid-season varieties. As a grazing oat the initial growth is not as vigorous as that of Dale but it is, however, very suitable for late winter or early spring feed.

The grain of Fulghum is suitable for oatmeal manufacture.

Dale.—This has given satisfactory results as a general purpose variety under a wide range of conditions. It is markedly superior to other mid-season varieties in respect to straw strength and is very suitable for early grazing.

Early Maturing.

Ballidu.—The standard early oat which has demonstrated its general superiority to Mulga in trials on research stations and is proving very satisfactory on farmers' holdings. The straw strength and grain yields are outstanding, whilst its vigorous leafy early growth and satisfactory recovery make it suitable for grazing and recovery.

Very Early Maturing.

Wongan.—The standard very early maturing oat which is notable for its vigorous early growth and strong straw. It is satisfactory as a hay variety although it is often rather short strawed. As a grain variety, it stands well but tends to shed if left unharvested too long after it has matured.

The vigorous early growth makes Wongan a suitable variety for early winter feed, but it cannot be grazed as late in the season as Ballidu and the mid-season varieties if recovery for grain is desired.

BARLEY VARIETIES.

Barleys are normally classified as being either two-row or six-row types and according to their suitability or otherwise for malting.

Suitable malting barleys are found both in the two-row and six-row types, but local maltsters' technique is based upon the use of the two-row types. Prior to the outbreak of war there was an expanding export of six-row malting types to the United Kingdom, but this has, owing to shipping and other difficulties, been temporarily suspended.

The selection of barley varieties for seed depends, therefore, upon the purpose for which the crop is to be grown. Practically all varieties in cultivation in Western Australia are early maturing and therefore the planting date will be dependent upon whether the crop is to be used for malting grain, fodder grain or green feed.

Barley for malting purposes is usually seeded during the latter half of May. When grown as a feed grain it is planted when convenient, usually after the wheat and oats have been sown. Barley for green grazing is customarily sown in April.

Description of the varieties available are:—

Atlas.—A six-row malting type barley introduced from California. It is also known in this State as Californian six-row barley. It is used in England for malting purposes in the production of light sparkling bottle beer and prior to the war exports of suitable samples were increasing substantially. This barley is also eminently suitable for green feed for which purpose it is at present mainly grown; a small quantity is used for malting locally in order to maintain a nucleus of the industry. It is very suitable also for feed grain purposes, being superior in yielding capacity to Cape. The results of trials with this typical six-row barley indicate that it is superior to oats as a source of early green feed, particularly at the time of the first grazing.

Prior.—A two-row barley which is the most important malting variety grown in the Commonwealth. Although it is generally considered that Prior is a strain of English Archer malting barley, there is no record of the variety from which it actually originated or the methods by which it was developed. This variety, which proved to be much more prolific and superior in malting quality to other malting barleys, was named after Mr. Samuel Prior, of Brighton, South Australia, who obtained one bag of seed of unknown origin from an Adelaide

seedsman in 1900. It was from this seed that the strain was developed, Messrs. Barrett Bros., maltsters of South Australia, being responsible for its initial distribution. Prior is also a useful variety for green fodder purposes.

Maltworthy.—Bred at the Roseworthy Agricultural College, South Australia, from a cross between Prior and Beavans Special. Maltworthy was named in 1939.

It is a two-row early mid-season maturing variety, which is strong strawed, and is superior to Prior in its resistance to strong winds when no occurrence of "necking" is evident.

Maltworthy possesses excellent yielding ability, and the malting quality of the grain appears to be satisfactory.

PURE SEED DISTRIBUTION.

The aim of the policy adopted with the distribution scheme for pedigree cereal seed is to provide as many farmers as possible with a few bags of the varieties grown by them and which are available from the Research Stations. The maintaining of "stud plots" by farmers is of major importance in the maintenance of the purity of their seed supplies and the small quantities of pedigree seed obtained by them is sufficient to establish such plots.

Objections have been raised from time to time by some farmers regarding the limiting of the quantity of each variety supplied to each applicant to a few bags only. If larger quantities were made available, however, it is possible that some farmers would not obtain any supplies of the varieties required by them for quite some years. Further, the Department grows quite a number of varieties for distribution and the actual quantity produced is limited by the area which it is possible to make available for planting at each station. Actually small quantities of each variety are quite sufficient to maintain pure seed supplies on the average farm. In this connection it is pointed out that each bag of wheat would sow at least four acres and each bag of oats or barley, three acres.

One objection raised quite often to small quantities is the extra trouble involved in harvesting small acreages; but where a farmer obtains regular supplies of the varieties he usually grows, there should be no difficulty or much extra trouble involved. With new varieties some extra work is, of course, involved but this could hardly be avoided with the introduction of a new variety on to a property and further, when new varieties are first distributed, the quantity available from the research stations is usually small in itself.

Requests are received from time to time that the pedigree seed be treated with a fungicide, for the control of ball smut, "pickling" as it is commonly termed, and in this connection it is pointed out that for a number of reasons it is not possible for this to be done. A considerable amount of work is involved in cleaning the grader between each variety, and if dusting was also included it would add to the difficulties of ensuring complete freedom from admixture.

All of the seed used on the Research Stations is dusted each year as a routine matter, copper carbonate is used for wheat, and a mercurial compound for oats and barley. Because of this the only danger of infection would be in transit after leaving the Research Station or on the farm before the seed is sown. Purchasers of pedigree seed from the Research Stations are advised that they could sow this seed unpickled with little fear of "bunt" or ball smut appearing in the crops. It should be remembered that untreated seed will run more freely than pickled seed.

With regard to the delivery of the seed every endeavour is made to have individual consignments forwarded as early as possible each year. However, owing to the large amount of work involved, it is not possible to consign any seed until March each year. Normally distribution, with the exception of late orders, is completed by the end of April at the latest.

In order to avoid disappointment in obtaining their requirements, farmers will assist considerably by noting the following directions:—

(1) All applications should be made direct to the Department of Agriculture, Perth.

(2) Applications should include the full name and postal address of the applicant and also the siding to which he desires the seed to be railed.

(3) Make early application.

(4) Forward cash remittance as soon as possible after receipt of statement of account. Statements of account are sent out in order of receipt of application.

(5) No definite reservations can be made until after receipt of the necessary cash remittance.

The cash prices per bag of three bushels for wheat, oats and barley, inclusive of rail freight to applicant's siding, will be:—

Wheat	35/-
Barley	30/-
Oats	20/-

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LICE AND TICK IN SHEEP

THE CONTROL OF TICK AND LICE IN SHEEP.

By C. R. Toop, Acting Chief Veterinary Surgeon.

OF the external parasites or vermin which infest sheep, the body lice and so-called ticks or keds are the most serious and unless steps are taken to control them by systematic dipping they may become a source of considerable loss to the flock owner.

The sheep body louse (*Damalinia ovis*) which is able to propagate under hot dry conditions has a wide distribution and occurs both in the agricultural and pastoral areas. The so-called tick or ked (*Melophogus ovinus*) has a much more restricted distribution and is confined to the higher rainfall areas of the South-West portion of the State.

Isolated cases of infestation with the sheep leg louse (*Linognathus pedalis*) also occur, but this parasite shows little tendency to spread throughout the flock and is consequently not of much economic importance.

Sheep infested with vermin show symptoms of skin irritation which causes them to rub against fences and other objects and to scratch and bite at the wool which in consequence presents a torn and ragged appearance. In heavy infestations the wool becomes matted and discoloured and is thereby depreciated in value. In addition the constant irritation of the parasites may result in considerable loss of condition and a reduction in the weight of the wool produced.

Sheep infested with louse and tick. Note torn and ragged condition of fleece, due to rubbing.

Tag of wool in mouth of sheep pulled out in its effort to get at the irritation.

For the detection of these parasites the wool should be opened and examined in a good light. Ticks, on account of their reddish-brown colour and relatively large size, are unlikely to be overlooked and when present will usually be found on the lower parts of the body, i.e. the belly, flanks and underside of the neck.

Lice are much smaller, measuring only 1/25 inch in length but their movements in the fleece will readily be detected when a close examination is made in a bright light.

A detailed description of these parasites is contained in the portion of this article which has been contributed by the Government Entomologist.

Wool on neck of infested sheep parted, showing ticks and pupae.

CONTROL BY DIPPING.

Dipping Fluids.

Vermin infestation in sheep may be controlled by systematic dipping. There are many reliable brands of sheep dip on the market and while none of these are specifically recommended by the Department all of them may be expected to give satisfactory results when used in accordance with the directions of the manufacturer. The choice of a dip, however, will depend upon the parasite it is desired to control, and in this connection it should be recognised that a dip which is effective against one type of parasite will not necessarily control another.

Recent research has shown that while arsenical dips are highly effective for the control of body lice, they cannot be relied upon to destroy tick. Conversely derris (*rotenone*) dips while destroying ticks are not effective for the control of body lice. Dips containing both arsenic and derris will of course, control both of these parasites.

Gammexane (*benzene hexachloride*) and DDT dips are similarly effective for the control of both tick and lice and in addition they possess a residual toxicity due to the retention of particles of the dip in the wool which should destroy any of the parasites which subsequently emerge. Both of these preparations, however, suffer a disadvantage in that they tend to "strip" or become reduced in strength during use and this is most likely to occur when a small volume of fluid is used for the treatment of a large number of sheep as in a shower spray or in a dip of small capacity. Allowance for this reduction in strength has, however, been made by the manufacturers when calculating the amount of dip which should be added to the bath to maintain the dipping fluid at an effective concentration and it is essential that directions supplied both with regard to the mixing and topping up or replenishment of gammexane or DDT dips should be strictly observed if satisfactory results are to be obtained.

For the control of leg lice, gammexane dips are recommended and may with advantage, be used at double strength, though this is not essential.

These recommendations may be summarised as follows:—

Body Lice—use arsenical gammexane or DDT dips.
Tick—use derris, gammexane or DDT dips.
Tick and Body Lice—use arsenic and derris, gammexane or DDT dips.
Leg Lice—use a gammexane dip.

Time of Dipping.

Best results will be obtained by dipping immediately after shearing. Recent investigations have shown that the closer to shearing that dipping is carried out the more effective it will prove to be. In order to avoid infection or the absorption of arsenic through open wounds, however, it is advisable to delay dipping until shear-cuts have healed. It may be noted, however, that under station conditions many thousands of sheep are dipped off the board without suffering any ill effects.

When it is realised that the majority of the parasites present in the fleece will be removed by shearing and those that remain will be more vulnerable to the effects of the dipping fluid while the wool is short the advantages to be gained by early dipping will be apparent.

The Stock Diseases Act Regulations require that sheep shall be dipped within six weeks of the date of shearing.

Eradication.

Although a single annual dipping will effectively control both tick and lice a second dipping carried out after an interval of about three weeks is necessary in order to completely eradicate these parasites from a flock. This will destroy any ticks or lice which have emerged from pupæ or eggs which have been unaffected by the first dipping. Due to its residual toxicity a single dipping only should be necessary to effect eradication when a gammexane or DDT dip is employed.

Careful Dipping is Essential.

Care should be exercised to ensure that the dip is of the correct strength and that the sheep are completely immersed. All sheep on the property (including lambs) should be dipped at the one time since any animals that are left undipped will soon re-infect the remainder of the flock. The capacity of the bath should be accurately estimated and the dip should be added in the proportions directed by the manufacturer and thoroughly mixed. The bath should be of sufficient length to ensure that the sheep will be completely immersed and saturated with

the dipping fluid and the head of each animal should be ducked beneath the surface as it swims through the dip. Where shower sprays are employed the sheep should be held long enough to ensure that all parts of the fleece are thoroughly saturated. When unsatisfactory results are obtained from dipping they can usually be attributed to failure to observe these precautions.

More detailed information with regard to dips and dipping is given in the succeeding paragraphs contributed by the sheep and wool adviser.

Dipping is Compulsory.

Under the Stock Diseases Act Regulations dipping is compulsory in the South-West division of the State as well as in the Dundas, Esperance, Westonia and Yilgarn Road Districts and those portions of the Merredin, Narembeen, Lake Grace and Phillips River Road Districts, situated outside the South-West Division. This legislation is necessary to ensure that tick and lice are controlled on individual properties and its purpose is to prevent the spread of vermin from infested to clean properties by the sale of undipped sheep. Systematic dipping connotes good sheep husbandry and on well managed properties it is practised as an annual routine, making compulsion unnecessary.

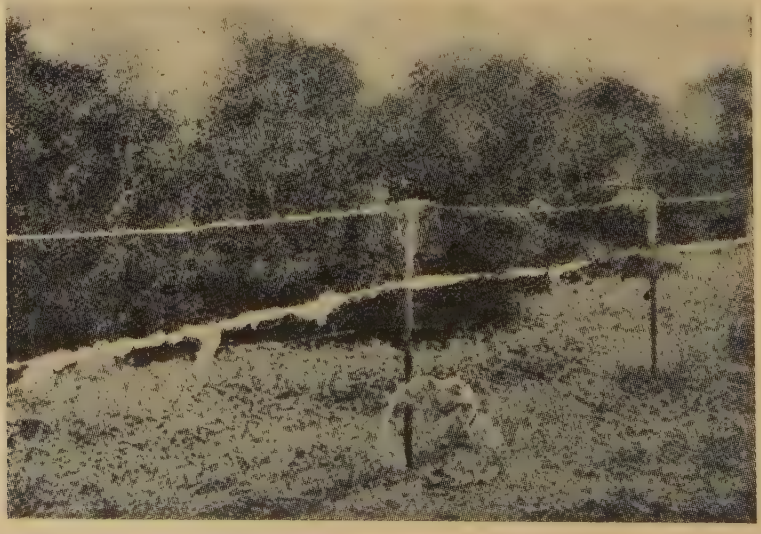
There are still many farmers and graziers, however, who are unmindful of the losses occasioned by the presence of vermin in their flocks and are indifferent to the losses that may be sustained by others from the indiscriminate sale of infested, undipped sheep. The enforcement of the dipping regulations is, therefore, essentail. A copy of these regulations has been appended for the information of sheep owners.

DIPPING FOR ERADICATION OF TICK AND LICE IN SHEEP.

W. L. McGARRY, Sheep and Wool Adviser.

THE complete eradication of tick and lice in flocks will pay handsome dividends in the form of more and better wool and healthier and heavier sheep.

If sheep are to thrive and be profitable they must be cared for, and regular and efficient dipping is an essential step in the welfare of the sheep.



Infested wool clinging to wire fence after sheep have been scratching.

A thorough dipping each year will keep sheep free of tick and lice. Evidence that this is not being done by some growers is revealed by an inspection of clips on show floors and examination of sheep at various sales.

The wool from infested sheep is discoloured, matted and usually has a bedraggled appearance due to the rubbing and scratching in an effort to relieve the skin irritation set up by the parasites. This fault in the wool considerably reduces the value of the clip.

Loss in Value.

At present prices a loss of up to 1s. per pound is sustained where a good type, good length, 64/60's quality agricultural wool carries a light infestation. A similar wool heavily infested would be reduced in value up to 1s. 6d. per pound. In addition to this severe loss, the constant irritation worries the sheep and causes a loss in condition and a reduction of fleece weights.

Summarised, infested sheep result in:—

(1) Less wool at a lower price.
(2) Less meat at a lower price.

Type of Dip.

Dipping can be carried out by running the sheep through a swim bath and by the use of shower or spray dips. Plans and specifications of swim dips in use at Agricultural Research Stations can be obtained upon application to this Department, and particulars of this type of dip are printed herewith. Plans and specifications of various types of swim and spray dips can also be obtained from stock firms.

Community dips could with advantage be erected to serve areas where flocks are small and/or where the cost of installing individual dips and draining yards is considered excessive.

A diagram of a side entrance to a swim dip which combines the slide-in principle is printed herewith.

Dipping Precautions.

In order to receive the maximum benefits from dipping a clean muster is absolutely essential. Only one infested straggler can, in time, cause the whole flock to be reinfested, and failure to achieve a clean flock after dipping, often attributed to various reasons, is actually the result of neglect in this direction.

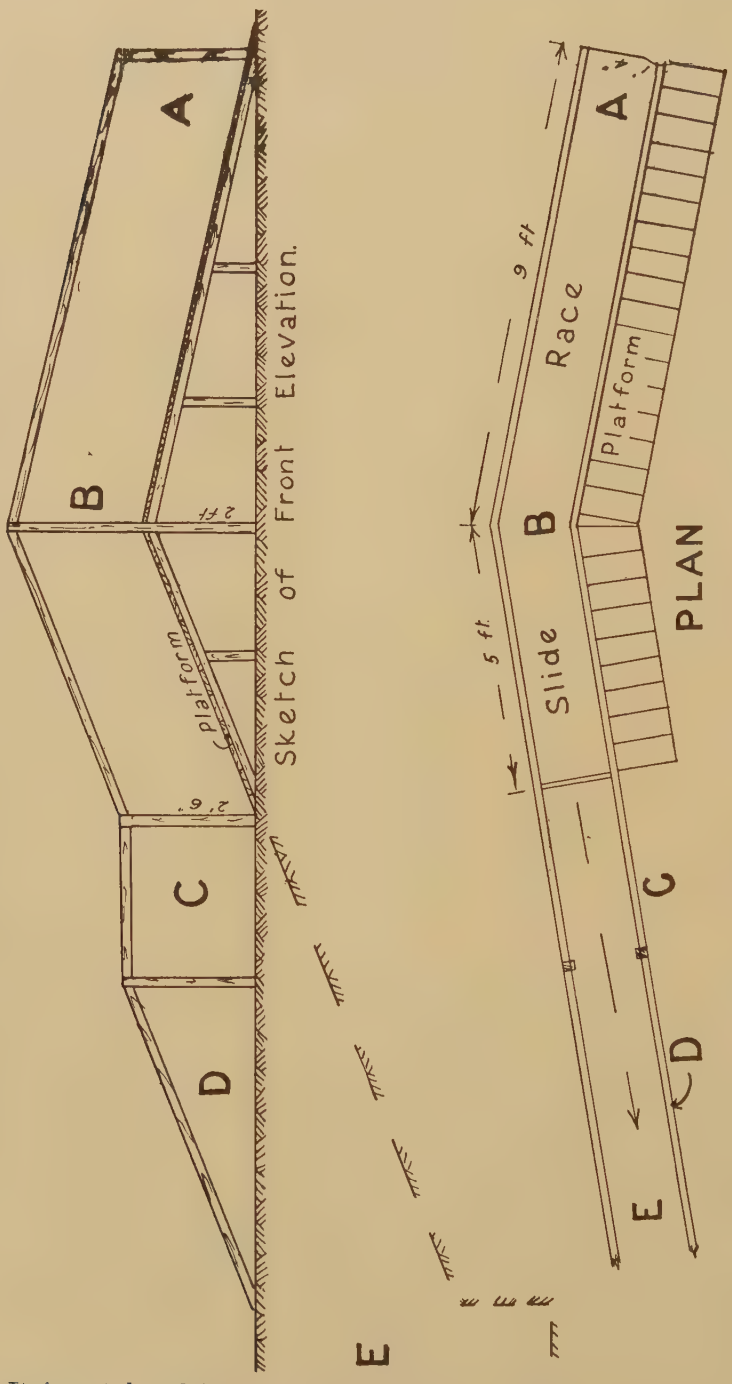
It is necessary to dip all the sheep and lambs, including ration sheep, at the same time unless arrangements are made to keep the dipped and undipped sheep strictly separate.

It is necessary to carefully follow the dip-maker's instructions on the packet or tin when preparing and using the dip.

Weather.

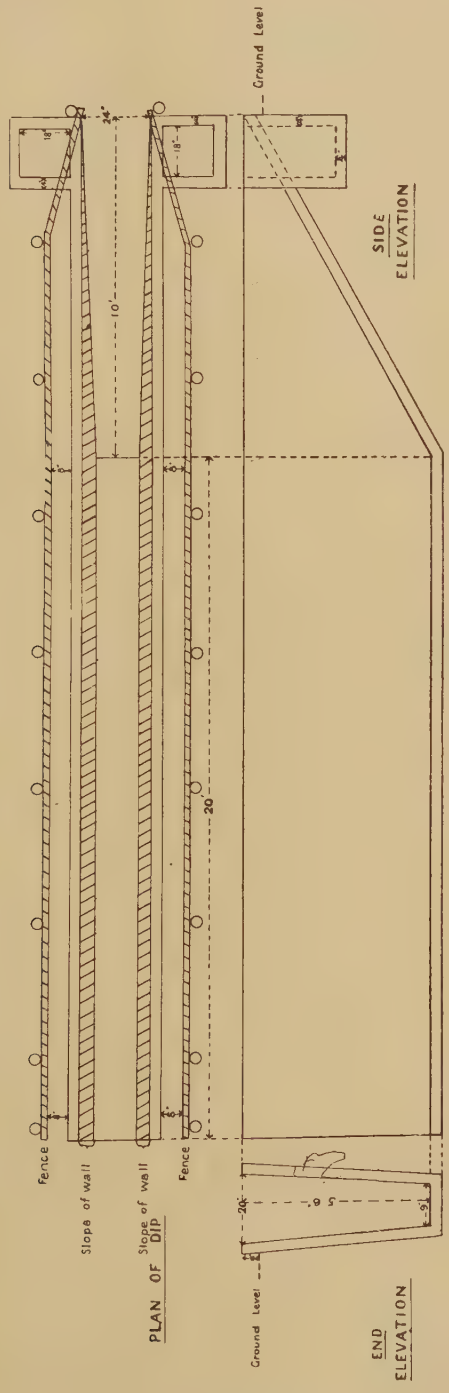
Do not dip in wet or very cold weather or in the hottest part of the day or under a broiling sun. Finish dipping early enough in the day to enable the sheep to dry out before sun-down. If heavy rain falls upon newly dipped sheep before they are dry, they will scald and mortality can occur. It is necessary to provide shade for the sheep whilst in the draining pens, because sheep that are soaked with dip fluid are liable to be scalded under a very hot sun.

DIAGRAM OF SIDE ENTRANCE OF SWIM DIP COMBINING THE "SLIDE IN" PRINCIPLE.



The 9ft. race A forms an obtuse angle with the 5ft. slide at B so that the sheep do not see the splash until they round the turn, by which time they are on the slide.
The Race A.—This is 9ft. long and rises from ground level to 2ft. above ground level at B. Sides are 2ft. 6in. high. Width of race 1ft. 4in. Floor of race is battened for first 3ft. A platform is provided for men to work sheep up race.
The Slide.—This is 5ft. long and falls 2ft. from B to bath. Floor of slide is plain galvanised iron. A piece of sack could be hung across slide about 2ft. from commencement is desired. C and D.—Continuation of sides of race at start of bath if desired. E.—Bath.

It is not beneficial to the welfare of the sheep and there is a risk of scalding if they are turned out into the hot sun or wind or driven immediately they come out of the draining pens. This should be avoided and whenever possible always allow the sheep to shade-dry in preference to sun-dry before they are driven any distance.


Ground Level
SIDE ELEVATION
10'
20'
Fence
Slope of wall
Slope of wall
Fence
PLAN OF DIP
Ground Level
END ELEVATION

Plan of dip.

Condition of Sheep.

Do not dip hot or thirsty sheep; yard them near the dipping site some time before dipping and allow the sheep time to rest and settle down and thoroughly cool off before commencing operations.

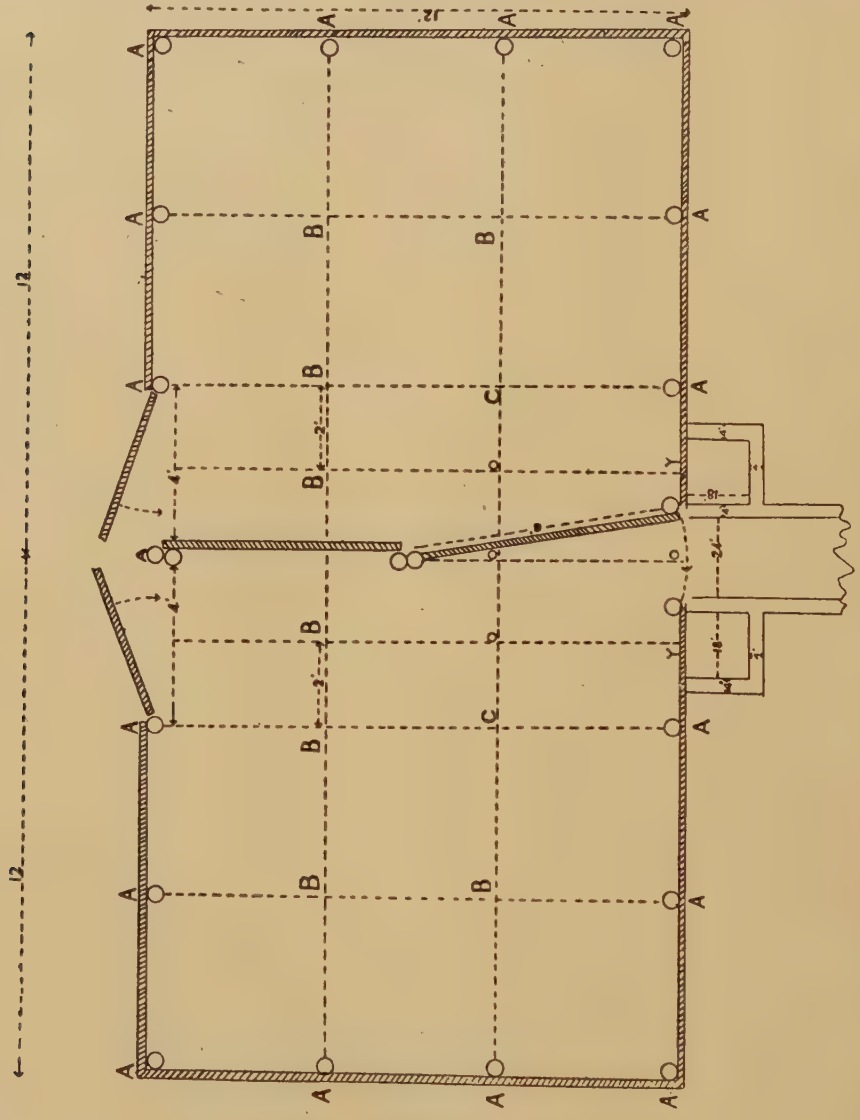


Fig. 18.—Plan of draining pens for sheep dip.

Sheep must not be driven immediately before or after dipping. If the sheep are over-driven or shedded after dipping there is a risk of scalding of the skin due to "sweating."

Sheep in poor condition are more susceptible to infestation than sheep in good condition, therefore good husbandry in this respect is important.

The fouling of the wash will be reduced if the sheep are as free as possible from dung, etc., when dipped.

Immersion.

To secure the best results from dipping the operation must be efficiently carried out and a thorough saturation of the wool is essential. This will not be achieved if the sheep are hurriedly rushed through the bath or spray. The sheep *must* remain in the bath or spray long enough to be thoroughly soaked to the skin. For this reason particular care is required when it becomes necessary to dip sheep carrying a fair growth of wool or when using short swim dips which are not recommended.

In swim dips it is necessary to plunge the sheep's head under twice with a guiding crutch, and the second plunge should be given just before the sheep reaches the exit slope. Always allow breathing time between the plunges and never hold a sheep under. When plunging the sheep always push them backwards. The sheep, particularly weak ones, should always be handled carefully.

When to Dip.

The entire flock should be dipped a few days after shearing is completed when the shear cuts will have healed.

Under station conditions dipping straight off shears is necessary.

Late dipping should be avoided. Late dipping can result in discolouration, lack of brightness and break in the wool which reduces the value per lb. When late dipping is unavoidable and the sheep are carrying a good growth it is necessary to reduce the dip strength.

Reinfestation.

No dip will protect sheep indefinitely after dipping and for this reason it is important to guard against reinfestation.

Reinfestation of clean sheep can be caused by:—

Failure to secure a clean muster for dipping.
The practice of not dipping lambs and dipping lambs, etc., at a different time from the dipping of the general flock.
Careless neighbours.
Failing to dip ration sheep.
Purchase of outside sheep that are infested.
Proximity to roads and travelling stock routes.
Boundary fences that are not sheep-proof.

SOME EXTERNAL PARASITES OF SHEEP.

C. F. H. JENKINS, Government Entomologist.

WITH the exception of blowflies, "tick" and lice are the most important pests affecting sheep in Western Australia. The term "tick" is quite misleading, as the true sheep tick does not occur in this State and the so-called "tick" of Australian graziers is a wingless fly which should be more correctly referred to as the Sheep Ked.

The lice are true insects with flattened bodies and strongly clawed legs admirably adapted for living amongst the sheep's wool.

Two types of lice occur locally, one having a broad squarish head and biting mouth parts and the other possessing a more pointed head and tubular mouth parts adapted for sucking blood. Both "tick" and lice are permanent parasites, all stages in the life cycle being passed through on the body of the host.

The Red-headed Sheep Louse (*Damalinia ovis* Schr.)

This is the common sheep louse in Western Australia. It is generally distributed throughout the South Western Division of the State and extends northwards—where its distribution is chiefly coastal—to about Port Hedland.

The insect measures about 1/25th of an inch in length. The abdomen is a pale brownish colour with several dark transverse bands. The reddish head is more densely pigmented, giving rise to the popular name of the parasite.

The mouth parts of this louse are adapted for feeding on the scurf and other debris lying on the surface of the skin. The situations most favoured are the neck, shoulders, back and thighs, but in severe infestations the insects spread to almost all parts of the body.

Red-headed Sheep Louse.
× 50.

Life History.

The eggs or "nits" of the Red-headed Louse are fastened on to the wool and hatch in from six to 10 days. The young closely resemble the parents in all but size, and after moulting or casting their skin several times reach sexual maturity in about 18 days. The adult female is said to lay 100 or more eggs.

The Foot Louse (*Linognathus pedalis* Osb.).

The Foot Louse is much larger than the Red-headed Louse, measuring about 1/12th of an inch in length. It has a short bluntly pointed head and mouth parts adapted for the sucking of blood. As its name infers, this species of louse is found chiefly on the hairy parts of the legs, but may spread to adjacent parts of the body.

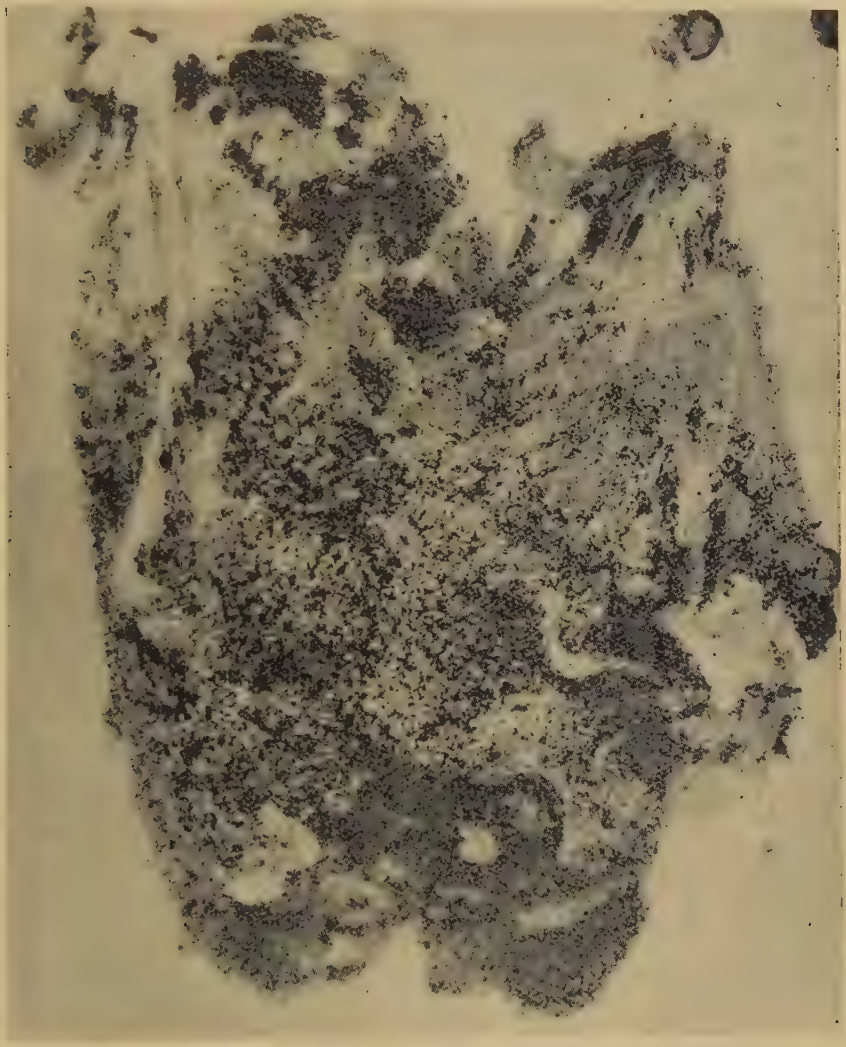
× 50 Male.

Sheep Foot Louse.

× 50 Female.

The Foot Louse is not common in Western Australia and has a very scattered distribution. Its permanent habitat seems to be in the vicinity of Carnarvon and other isolated Gascoyne localities. Records from South-West districts have been received, but usually such infestations have been traced to the introduction of sheep from northern stations.

The life history of this louse differs only in detail from that of the Red-headed Louse.



Portion of wool from fetlock showing masses of louse eggs or "nits."

The Sheep Ked or "Tick" (*Melophagus ovinus* L.).

As stated earlier in this article, the so-called sheep tick of local farmers and pastoralists is really a wingless fly. The true tick is an eight-legged creature, whereas the Sheep Ked has the six legs typical of insects. On account of its high

specialisation as a parasite, the wings have been lost, although there are close relatives of the Sheep Ked which parasitise birds and various wild and domestic animals in which wings are present. These flies are often known as louse-flies.

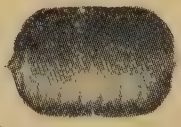
The Sheep Ked measures about ¼ inch in length and is reddish or grey-brown in colour. The abdomen is disproportionately large and swollen, especially when the insect is well gorged with blood. The mouth parts are adapted for blood sucking, and protrude as a conspicuous "proboscis" in front of the head.

When disturbed the keds move very rapidly through a fleece, darting sideways and backwards at will very much like a crab. The neck, breast, shoulders, belly and thighs are the favoured locations on the host.

The Sheep Tick—Female.
× 13.

Life History.

The eggs of the Sheep Ked are retained by the female until they hatch, and the larvae or maggots are not deposited until fully-grown. They are then attached to the wool fibres and immediately pupate. The entire life cycle is, therefore, passed on the sheep and yet no eggs or active maggots will be seen on an infested



Pupa of Sheep Tick.

animal. The keds emerge from the brown barrel-shaped pupae in about 22 days and reach sexual maturity after a further fortnight or three weeks. A single female ked is considered to be capable of producing about fifteen pupae.

Means of distribution and survival capacity of Lice and Keds.

Lice and keds never voluntarily leave the body of the host animal and are incapable of breeding or surviving long periods away from their normal environment. The adult ked, however, has been reported to live as long as 18 days detached from the sheep, and pupae have been recorded to survive as long as 42 days in tags of wool.

The survival period of lice detached from the host is usually given at about five days, but this will naturally vary according to whether the insect is exposed in a paddock or protected in a shearing shed.

From the foregoing it will be apparent that sheep may become infested in two ways. Close contact between clean and infested sheep in yards, trucks and shearing sheds probably contributes mostly to the spread of the pests, but the danger of tags of wool lying about shearing shed floors and adhering to the sides of sheep pens cannot be ignored.

To summarise these aspects, therefore, it is apparent that both lice and tick do not customarily survive long periods away from their hosts. On the other hand, individuals may exist for several weeks and so the contamination of shearing sheds, paddocks, trucks, etc. by sheep which have already passed on cannot be ignored.

In the case of lice a stock free period of about a month has been recommended to ensure complete decontamination of shearing sheds, paddocks etc. after infested sheep; for the "tick" or ked the safety margin has been placed at two months.

Effect of Lice and Ked infestation on sheep.

The presence of lice and keds can be detected by the scraggy and ragged appearance of the infested animals. The irritation caused by the feeding of any of the parasites greatly disturbs the stock and causes them to be constantly scratching, biting or rubbing the affected areas. In the case of blood-sucking foot louse and ked infestations, the actual loss of blood involved also helps to weaken the host. Affected sheep rapidly lose condition, and the standard of the fleece is adversely affected.

Prevention and Control.

Control measures are outlined elsewhere in this article and the importance of carrying out these measures regularly and carefully cannot be over emphasised. Every farmer, however, should strive to keep his flock entirely free of tick and lice, and the most effective way of doing this is to see that infested animals are not brought on to the holding.

Fresh purchases should be carefully examined before being given a free run of the property, as prompt action in connection with a few head of stock may often prevent widespread trouble later in the season.

STOCK DISEASES ACT REGULATIONS.
PART VI.—SHEEP AFFECTED WITH TICK AND LICE.

Dipping or spraying of sheep compulsory in specified areas.

63. (1) Subject as hereinafter provided and unless otherwise authorised by the Chief Inspector of Stock, every owner of sheep within the boundaries of the Districts specified in paragraph (2) of this regulation, shall within six weeks after

the date of shearing dip or cause to be dipped in a swim bath or saturated by a shower spray approved by the Chief Inspector of Stock, and prepared from some specific known to be fatal to tick and lice all sheep running upon land whereof he is the owner or occupier.

(2) This regulation shall apply to the South-West Division of the State to the Dundas, Esperance, Westonia, and Yilgarn Road Districts as constituted under the Road Districts Act, 1919-1946, to all those portions of the Merredin, Narembeen, Lake Grace and Phillips River Road Districts situate east of the No. 1 Rabbit Proof Fence, and to any other such Road District which may subsequently be specified by a notice published in the *Government Gazette*.

Penalty for having affected sheep on property.

64. (1) If any sheep affected with tick or lice shall be found upon any property on which sheep are grazed, the owner or occupier of the land on which the affected sheep are depasturing shall be guilty of an offence, and any Inspector may give notice to the aforesaid owner or occupier of the land on which the affected sheep are depasturing forthwith to dip, spray, or dress the sheep in such manner and at such place as the Inspector of Stock may direct, and every such owner or occupier who refuses, neglects, or fails to comply with the aforesaid notice, shall be liable to a further penalty.

(2) No sheep affected with tick or lice shall be offered for sale privately or by auction or removed from the property on which the sheep are being depastured until they have been dipped in or sprayed with some specific known to be fatal to tick and lice, provided that permission may be granted by the inspector to remove them to an approved dipping or spraying place.

Sheep infested with tick or lice must be dipped or sprayed.

65. (1) If an Inspector is satisfied that stock depasturing in any part of the State is affected with tick or lice, he shall give the owner thereof notice to dip or spray such stock forthwith to the satisfaction of the Inspector or his agent. And any owner who refuses, neglects, or fails to comply with such notice on or before the date specified therein shall be liable on conviction to a penalty not exceeding fifty pounds for the first offence, and if immediately after conviction for the first offence such stock shall not be dipped or sprayed to the entire satisfaction of the Inspector, such owner shall upon conviction be liable to a further penalty not exceeding fifty pounds, and so on for each and every succeeding conviction.

(2) If any sheep affected with tick or lice shall be found in any pound, or in any yard or yards or on any land or other place at which sheep are offered for sale or exhibited for show purposes, the owner exposing the sheep so affected shall be liable to a penalty not exceeding fifty pounds, and any Inspector, if he deems it necessary, may order the withdrawal from sale of any sheep affected with tick or lice until such sheep have been dipped, sprayed, or dressed to the satisfaction of such Inspector or any other Inspector, and may give notice to the aforesaid owner of such sheep to dip, spray, or dress the same forthwith, at such place as the Inspector may direct, and every such owner who refuses, neglects, or fails to comply with the aforesaid notice shall be liable to a further penalty not exceeding twenty pounds.

But if the Inspector is satisfied that such sheep are intended for immediate slaughter, he may withhold such notice to dip or spray.

66. Every owner, occupier, or person in charge of any holdings in the South-West Division of the State shall, before the removal of any stud sheep, make a Statutory Declaration, according to Form No. 5 in the Third Schedule

hereto, that such sheep are free from tick and lice. If such sheep are found to be suffering from tick or lice, such owner, occupier or person in charge shall cause them before removal to be dipped in a swim bath or saturated by a shower spray, approved by the Chief Inspector of Stock and prepared with some specific known to be fatal to tick and lice, and shall make a Declaration, according to Form No. 6 in the Third Schedule hereto, that they have been so dipped or sprayed.

Statutory Declaration to be Supplied within fourteen days after dipping or spraying.

67. Within fourteen days after the dipping or spraying of his sheep the owner shall make a Statutory Declaration before a Justice of the Peace, to the effect of Form No. 7 in the Third Schedule hereto, stating that he has dipped or sprayed his sheep in accordance with the provisions of these regulations, the date of dipping of spraying, the number of sheep dipped or sprayed, and the class of dip or spray used, and he shall forward such declaration to the Chief Inspector of Stock.

Ewes with Lambs—Time for dipping or spraying.

68. Not withstanding anything contained in these regulations, it shall not be necessary to dip or spray ewes affected with ticks or lice during such time previous to or after lambing as the Inspector may appoint, and for such purposes any Inspector may, in respect of such ewes, extend any notice to dip or spray for such time as he shall think fit.

Affected Stock not allowed to Stray.

70. Every person who by himself, his agent or servant, drives, without the permission of an inspector, or suffers to stray across or upon any land, or drives, depastures, or suffers to stray upon or along any highway any sheep which have not been dipped according to these regulations, or which are affected with ticks or lice shall be liable on conviction to a penalty not exceeding fifty pounds.

Form No. 5 (Regulation No. 66).
Western Australia.

Department of Agriculture.

The Stock Diseases Act, 1895.

DECLARATION.

I,(1).....
of(2).....
in the State of Western Australia(3).....
do solemnly and sincerely declare that.....stud sheep
now on my holding, which stud sheep I have sold to.....
.....of.....
are free from TICK AND LICE.

And I make this solemn declaration by virtue of Section One hundred and six of "The Evidence Act, 1906."

Declared at.....
this.....day of.....19 ,
before me,
.....
Justice of the Peace.

(4).....

(1) Christian name or names and surname of declarant in full.
(2) Address.
(3) Calling.
(4) Ordinary signature of declarant.

(To be forwarded to the Chief Inspector of Stock.)

Form No. 6 (Regulation No. 66).

Western Australia.

Department of Agriculture.

The Stock Diseases Act, 1895.

DECLARATION.

(No- 28 of 1906.)

I,(1).....

of(2).....

in the State of Western Australia(3).....

do solemnly and sincerely declare that.....stud sheep which were sold by me to.....

of....., and which were found by me to be suffering from Tick (or Lice), were within..... of their removal from my holding dipped in or sprayed with (state material used).....

.....

in the proportion of (quantity of dip or spray used and how diluted).....

.....

Declared at.....

this.....day of.....19.....,

before me,

(4).....

.....

Justice of the Peace.

(1) Christian name or names and surname of declarant in full.
(2) Address.
(3) Calling.
(4) Ordinary signature of declarant.

(To be forwarded to the Chief Inspector of Stock.)

Form No. 7 (Regulation No. 67).

Stock Diseases Act, 1895.

DECLARATION.

I,....., of.....,

situated in the.....Road District in the State of Western Australia, do solemnly and sincerely declare that I have dipped or sprayed the whole of the sheep at present depasturing on my farms and runs, and belonging to me, and at present in my possession.

No. of sheep dipped.....

Brand and Quantity of Dip used.....

Date of Dipping...../...../19.....

And I make this solemn declaration by virtue of section one hundred and six of the Evidence Act, 1906.

Declared at.....

this.....day of.....19.....,

before me,

.....

Ordinary Signature of Declarant.

.....

*Justice of the Peace or other authorised person.

* Pursuant to section 2 of Act No. 12 of 1913, the following persons are authorised to attest Statutory Declarations:—Town Clerk, Secretary to Road Board, Electoral Registrar, Post Master, Classified officer of State or Commonwealth Public Service, Classified State School Teacher, Member of Police Force, Commissioner of Declarations.

EXPORT OF WESTERN AUSTRALIAN FRUIT

An Account of a Non-refrigerated Shipment of Oranges, Apples and Tomatoes to Singapore.

H. R. Powell, Superintendent of Horticulture.

A VISIT to Singapore aboard the M.V. "Charon" which left Fremantle on the 5th November, 1947, provided an opportunity to collect weather data and other information bearing on the out-turn of a non-refrigerated shipment of fresh fruit. Through the courtesy of Mr. E. H. Lewington, Shipping Manager of Dalgety & Co., agents for the Blue Funnel Line, and the Master of the Vessel, Captain Marriott, every facility was provided to enable the necessary information to be obtained.

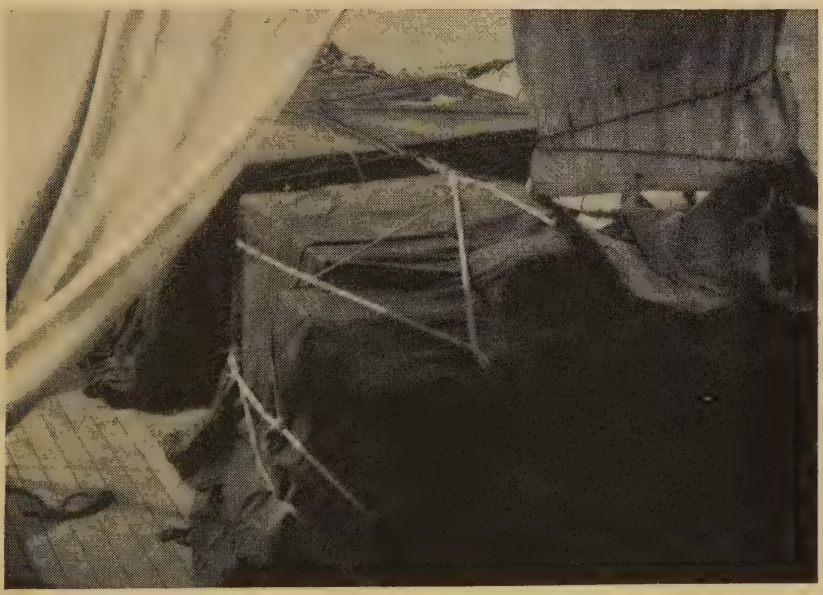


Plate 1.—Deck stowage on the M.V. Charon. The fruit is well protected from damage by heavy rain. In the upper left and right hand corners appear portions of the canvas wind chute used to ventilate sheep and fruit in the lower and upper cattle decks. (Photo by H. R. Powell.)

The fruit cargo loaded at Fremantle consisted of 2,422 bushel cases of Valencia oranges and 100 cases of Granny Smiths, stowed on deck and 1,018 cases of Valencias, 27 cases of lemons, and 100 cases of Granny Smiths stowed in the No. 1 'tween deck. The No. 1 'tween deck was loaded on the 3rd November and No. 2 and No. 4 decks on the 4th. At Geraldton 1,066 half bushel cases of tomatoes were loaded as deck cargo.

It was realised that it was too late in the season for commercial non-refrigerated shipments of apples but the Granny Smiths were made available by the Superintendent of the State Committee of the Apple and Pear Marketing Board (Mr. R. M. Carter) for the purpose of obtaining regular pulp temperatures

and other information. The apples consisted of a range of sizes including 2¼ inch, 2½ inch and 2¾ inch, and were divided into two lots each of 100 cases, consisting as far as possible of fruit of similar quality and size range.

Owing to unforeseen circumstances it was not possible as originally planned to inspect the fruit prior to loading and obtain a range of pulp temperatures.

Through the kindness of the Weather Bureau and the Mt. Barker Co-operative Ltd., two bimetallic thermographs and a hair type hygrograph were made available. In addition an alcohol pulp thermometer, two wet and dry bulb hygrometers, and a mercury thermometer graduated to 260°F. were used. The thermometer and thermograph were checked prior to sailing.

Plate 2.—Deck stowage on the M.V. Charon.
(Photo by H. R. Powell.)

A continuous record of temperatures was obtained during the voyage, also at Singapore, and during the return trip to Fremantle on the M.V. "Gorgon," altogether a period of approximately five and a half weeks. Unfortunately, the records from the hygrograph are incomplete owing to the movement of the vessel affecting the mechanism of the instrument.

The fruit was stacked partly on deck and partly in 'tween decks. On deck the oranges were split into four stacks of which two, each comprising 800 cases, were loaded forward on the port and starboard sides. The rest were stowed in two stacks aft. One hundred cases of apples were included in one forward deck stack, while the tomatoes were divided between the four stacks. Resting on dunnage, the cases were loaded five high mostly on their sides and covered by trapaulins which left only a few cases on the rails and around the base of the stacks exposed.

The fruit carried in the 'tween deck consisting of 1,018 cases of oranges and 100 cases of apples was block stacked eight cases high on dunnage between two open hatches with passage ways on three sides.

Deck Temperatures.

Temperatures were recorded on two thermographs placed in the cabin on the promenade deck and on the starboard orange stack in the 'tween deck, as well as by thermometer readings taken at intervals during the day at various points.

Table 1 sets out the range of temperatures encountered after leaving Geraldton at 6.30 a.m. on Friday, 7th November. The points selected for checking temperatures were as follows:—

(a) Shade—Forward deck.

(b) Shade—After deck.

(c) Shade—'Tween deck.

With the exception of the 'tween deck figures which are averaged from three readings, the other figures are the average of two readings. There were occasions when it was impossible to take readings at the correct time and these variations are shown on the table.

The weather at Perth prior to departure, was relatively cool. Maximum and minimum temperatures as recorded by the Weather Bureau were as follows:—

	Max. F.	Min. F.
Tuesday, 4th November	71°	56°
Wednesday, 5th November	79°	52°

Temperatures rose steadily after leaving Geraldton, the hottest period being encountered after leaving Onslow between Monday 10th and Friday 14th when shade temperatures ranged at noon from 83° to 86°, forward, and from 83° to 91° aft. Thereafter until Singapore was reached on the morning of the 17th, cooler conditions prevailed.

Many variable factors affected temperatures in the 'tween deck during the voyage, such as the force and direction of the wind, the use of the canvas wind chute and subsequent unequal distribution of the fresh air, the sheep, and the proximity of the crew's quarters, etc. Differences as great as 5° were noted between various points.

No facilities for mechanical ventilation of the fruit in the cattle deck were available. The hatch covers were removed during the voyage, and this coupled with the fact that the cattle ports were open ensured the movement of air through the stack of fruit, whilst the necessary favourable winds were available. A canvas wind chute rigged up well above the open hatch, was used for three days after leaving Broome on the 12th November, to provide additional ventilation. Heavy rain and rough weather experienced from the 15th November, until Singapore was reached made it unnecessary for it to be used again.

After leaving Broome the weather experienced on this particular voyage was characterised by strong winds and rain. It could be expected however, that on many occasions in these tropical areas the weather would be hot and humid with little, if any, wind. On these occasions the use of the wind chute could not provide sufficient ventilation.

A system of forced air circulation would be an insurance against unfavourable weather conditions and would benefit both the fruit cargo and livestock carried.

Figure 1 sets out graphically the average temperatures obtained at various points at each reading during the period 10th-14th November. This period is taken as insufficient data was collected either before or afterwards.

TABLE I.

SHADE TEMPERATURES, NOVEMBER, 1947.

Date.	Cabin.					Forward Deck.					After Deck.					'Tween Deck.				
	9 a.m.	12 noon.	3 p.m.	6 p.m.	9 p.m.	9 a.m.	12 noon.	3 p.m.	6 p.m.	9 p.m.	9 a.m.	12 noon.	3 p.m.	6 p.m.	9 p.m.	9 a.m.	12 noon.	3 p.m.	6 p.m.	9 p.m.
7th	65	67	72	72	....	....	71	72	69	....	....	75	73	....	....	....	71	71	70	....
8th	69	71	74	75	77*	71	....	76	75	75*§	75	....	79	76	....	70	....	75	75	75*§
9th	75	74	77	77	75	79	78	....	77	74§	79	....	....	78	....	72	73§	75	....	74§
10th	75	76	78	79	78	79	83	79	78	77	83	83	80	78	77	76	78	78	79	78
11th	81	....	83§	....	81†	84	....	87	....	....	85	....	87	....	....	82	....	82	....	....
12th	83	82	82	83	81	86	83	82	81	81	89	87	86	82	....	83	81	81	81	80
13th	82	83	83	85	84†	85	86	86	83	83†	87	91	87	85	83	82†§	83	83	84	83†§
14th	81	83	84	84	82†	80	86	85	83	81†§	82	89	88	86	81	79†§	83	79	81	80†§
15th	78	78	79	79	81†	76	....	77	78	79†§	78	77	....	....	80	78†§	....	76	77	79†§
16th	79	80	81	82††	83†	....	81	81	....	....	....	81	84	....	....	77	79	80	....	....

* 10.0 p.m. † 10.30 p.m. †† 7.30 p.m. § Single readings.

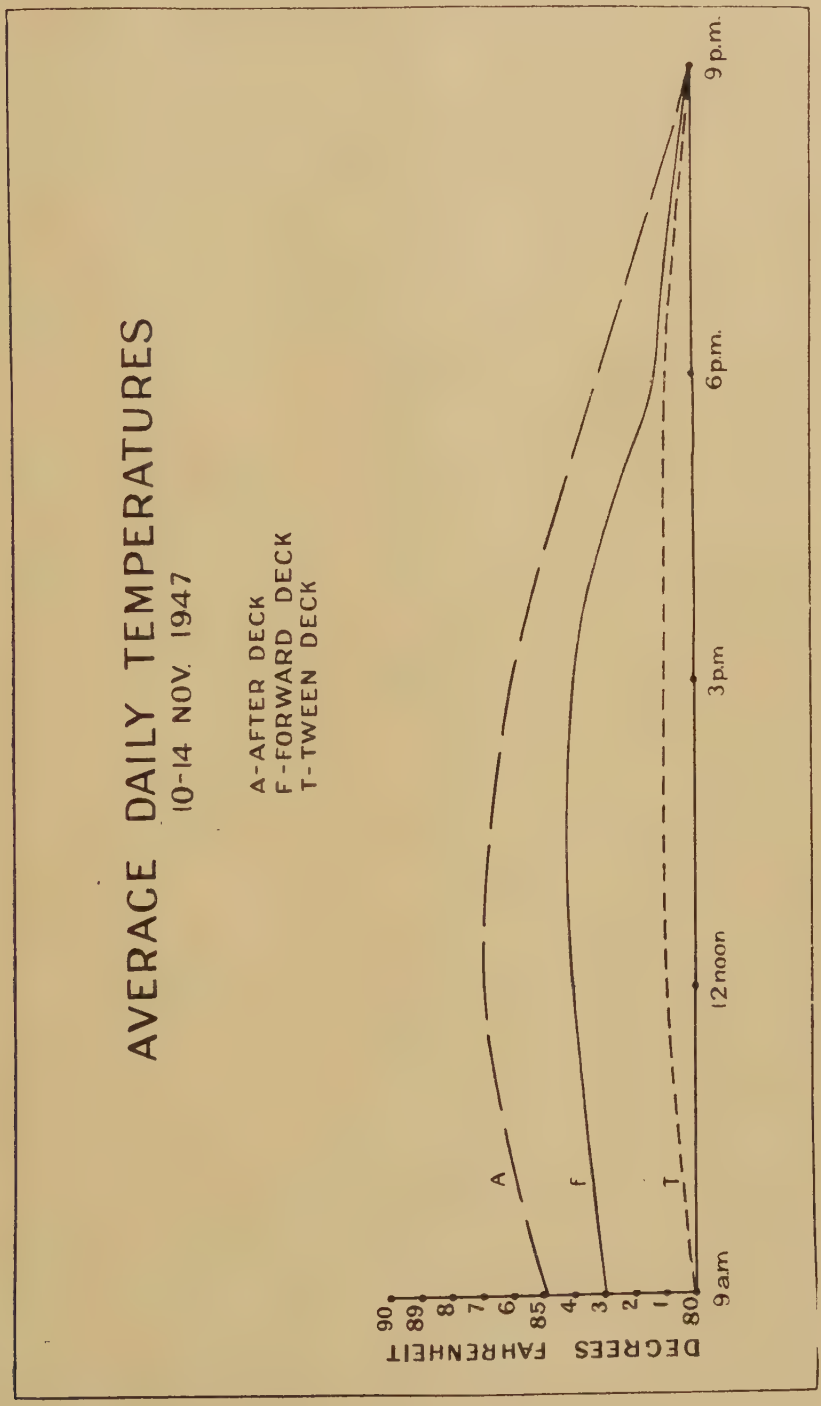


Figure 1.—Average daily shade deck temperatures.

The average shade temperatures on the forward deck were generally 2° cooler than the average temperatures on the after deck, except at noon when the difference was 3° and from 6 p.m. onwards the temperatures, on both decks tended to equalise at approximately 80°.

The average 'tween deck temperatures were lower than those recorded on the forward deck. With the exception of 6 p.m. onwards, when temperatures on both decks tended to equalise at about 80° the difference in favour of the 'tween was approximately 3°.

To sum up, during the period 9 a.m. to 3 p.m. average 'tween deck temperatures were approximately 5° lower than those recorded on the after deck, and 3° lower than the forward deck. After 3 p.m. each day all temperatures tended to equalise, and by 9 p.m. a uniform average temperature of approximately 80° was reached.

Pulp Temperatures.

From the 12th November regular daily pulp temperatures were taken of the apples and oranges. On deck the top and middle layer of a case of apples situated just under a black tarpaulin were checked as well as the next case directly underneath. In the 'tween deck a case of apples and also a case of oranges were used. Table 2 sets out the results obtained, and these are graphically illustrated in Figure 2.

TABLE 2.

PULP TEMPERATURES (F).—APPLES—GRANNY SMITHS.

10.0 a.m.

	Forward Deck (Starboard).				'Tween Deck.		
	Shade Temp. 9 a.m.	Top Layer Top Case.	Middle Top Case.	Case Middle Underneath.	Shade Temp. 9 a.m.	Middle Top Case.	Oranges.
Friday 7th	....	73	67	65	....	65	....
Saturday 8th	71	72	70	66	70	70	....
Sunday 9th	79	75	73	71	72	73	....
Monday 10th	79	75	73	71	76	73	....
Tuesday 11th	84	80*	80*	78	82	78	....
Wednesday 12th	86	95	89	85	83	83	82
Thursday 13th	85	92	85	85	82	84	83
Friday 14th	80	86	85	85	79	85	83
Saturday 15th	76	83	83	83	78	82	80
Sunday 16th	....	80	80	80	....	81	80
Average	....	81	78	77	....	77	82

*Beyond capacity pulp thermometer.

As perhaps could be expected, the highest temperatures were recorded in the top layer of the top case which was directly underneath the tarpaulin. The pulp thermometer was used until the 11th November, when some of the temperatures exceeded the capacity of the instrument, and thereafter a mercury thermometer was substituted. It will be seen from the table that there was a gradual increase in the temperature from 73° on the 8th to 95° on the 12th which was the highest temperature recorded. Towards the end of the voyage temperatures tended to equalise at about 80° due to cooler weather conditions.

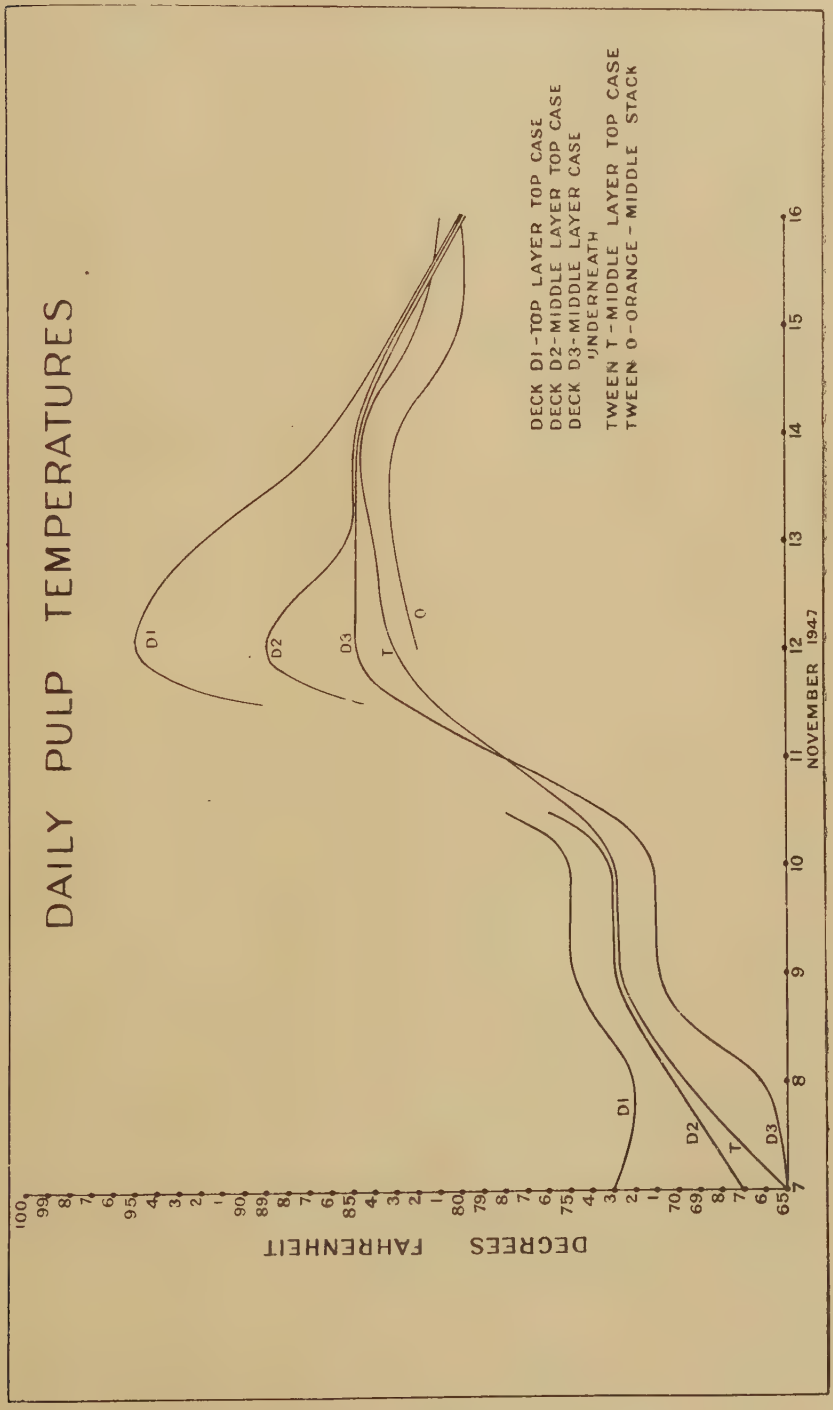


Figure 2.—Pulp temperatures of apples and oranges.

The apples in the middle of the top case were also quickly heated, but not quite to the same extent as the top layer, and this applied to a lesser extent to the case underneath. Average pulp temperatures during the period were as follows:—

(a) Top case—top layer .. .. 81°
(b) Top case—middle .. .. 78°
(c) Case underneath .. .. 77°

Temperatures on the 11th were above the limits of the thermometer and, therefore, could not be included in the average figures for (a) and (b). It is estimated, therefore, that the true figures would be one degree higher.

From Figure 2 it will be seen that the highest temperatures were recorded on Wednesday 12th. The temperature of the apples in the top layer of the top case was 95° or 6° higher than fruit in the middle layer of the case and 10° higher than apples in the middle layer of the case underneath. Subsequently pulp temperatures declined until on the day before berthing all three were in the vicinity of 80°.

In the 'tween deck the average pulp temperature of the apples in the middle layers of a top case of the stack was 77°. Daily temperatures, however, did not rise beyond 85°, and this figure was reached on Friday 14th, three days prior to berthing. Thereafter readings gradually declined to approximately 81°.

Stack Temperatures.

As all fruit on deck was covered directly with tarpaulins with no air cushion between the top cases and the coverings, an attempt was made to ascertain some of the temperatures experienced in various positions of the stacks. The readings were taken each morning at 11 a.m. and the results as set out in Table 3 indicate that very high temperatures were experienced, particularly on four occasions. As could be expected these were recorded directly under the tarpaulin on top of the orange stack, the highest reading being 120°. The direct effect of the sun was also experienced in front of this stack. Temperatures taken elsewhere were not so high and indicate, with support from the pulp temperatures of the apples, that the fruit not directly heated by the sun through the coverings was not subject to such high temperatures. On a portion of the front of the stack a stained white covering was used. On the 14th temperatures under both coverings were tested—the black was 107° and the white 94°.

TABLE 3.
FORWARD DECK STACK TEMPERATURES (STARBOARD).
11.0 a.m.

	Front Orange Stack Under Tarpaulin Top.	Front Orange Stack under Tarpaulin Bottom.	Behind Apple Stack under Tarpaulin Bottom.	Behind Tomato Stack under Tarpauiin Bottom.
Monday, 10th	104	88	85	85
Tuesday, 11th	120	102	92	89
Wednesday, 12th	92	82	82	85
Thursday, 13th	115	90	84	85
Friday, 14th	107	83	83	84

Plate 3.—Showing improved deck stowage, using a metal framework covered with tarpaulins.
(Photo by A. G. Strickland.)

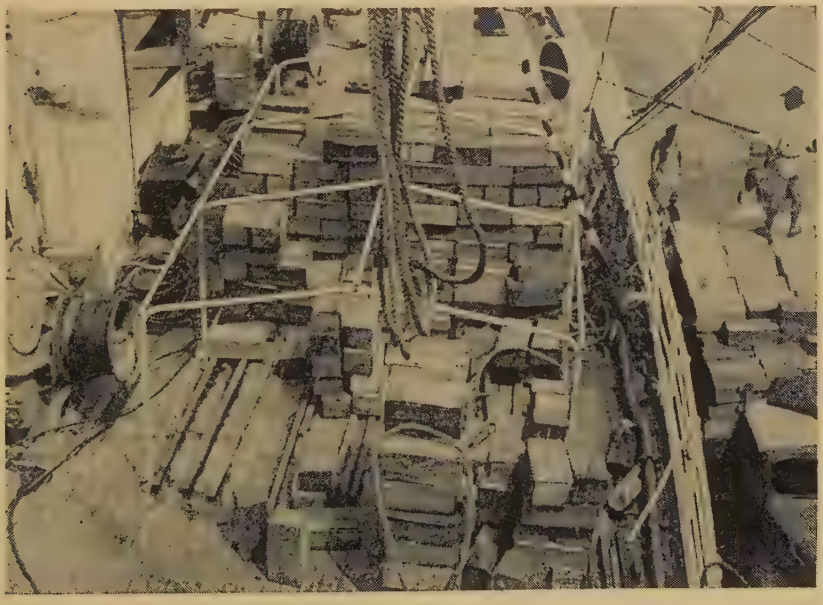


Plate 4.—Showing the method of stacking cases under the framework.
(Photo by A. G. Strickland.)

It can be mentioned that the uncovered sections of the deck stacks, particularly aft, were subjected to the direct rays of a very hot afternoon sun for days. Sun temperatures would be in the region of 120°. Oranges were

exposed particularly through the crevices caused by bulged lids. Wet weather experienced towards the end of the voyage prevented a close inspection of fruit in this and other sections.

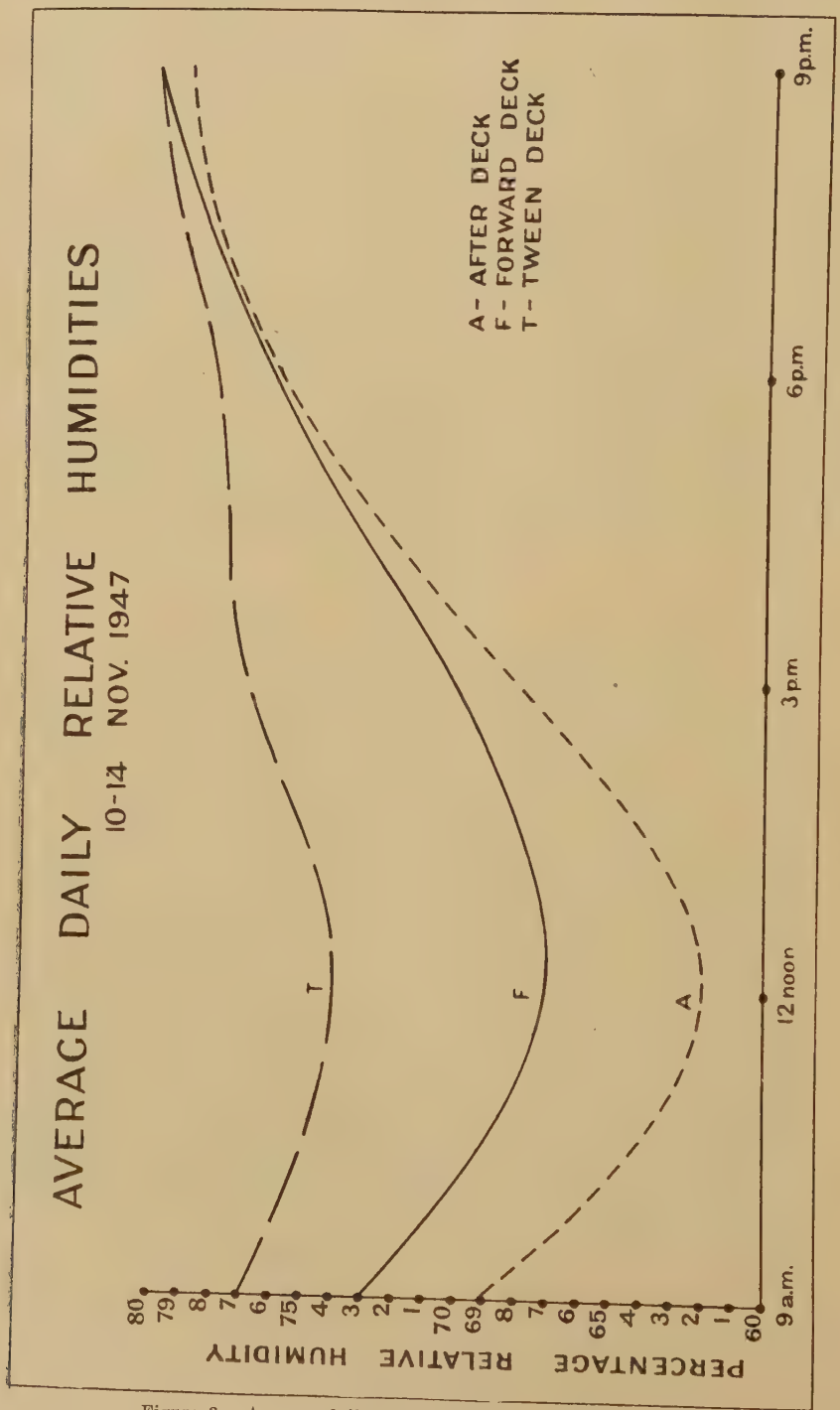


Figure 3.—Average daily relative humidity readings on deck.

The cases stowed in front of the stacks on the forward deck and those on the rails, particularly forward, were subjected to some wetting by sea spray and rain. During fine weather the coverings on the sides of the stacks, were lifted.

The method used during the voyage for covering the deck stacks is illustrated in Plates 1 and 2. However, following representation to the shipping company, light metal frameworks have now been installed for supporting the tarpaulins as shown in Plates 3 and 4, which have been kindly made available by Mr. Strickland. An air space between the cover and the fruit is thus provided to eliminate excessive heating of the outside cases, while all fruit is given complete protection against direct sunshine and sea spray.

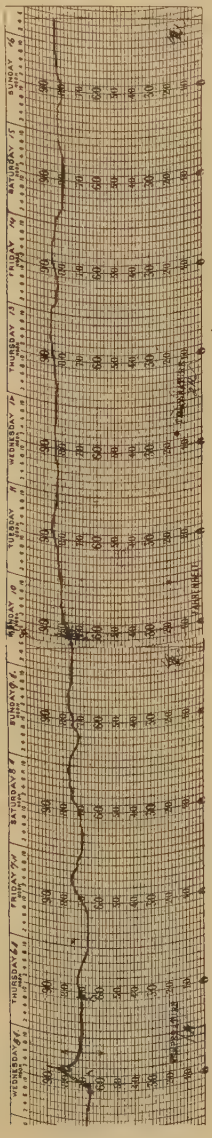


Figure 4.—Thermograph—Tween deck temperatures—M.V. Charon.

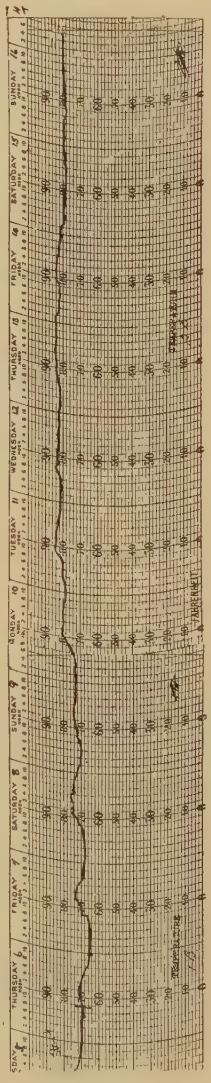


Figure 5.—Thermograph—Cabin temperature—M.V. Charon.

Continuous Temperature Records.

Thermographs situated in the 'tween deck and cabin respectively gave continuous records of temperature fluctuations in these positions during the voyage. Graphs were also taken at Singapore and on the return voyage. Reproductions of these records are included in Figures 4, 5, 8, and 9.

Until the 9th when the vessel left Onslow there was a difference of 6°-10° between maximum and minimum daily temperatures. Thereafter the graphs tend to straighten out showing less difference between maximum and minimum temperatures. During the last two days, when unsettled weather was encountered, the difference between 'tween deck maximum and minimum temperatures was 2°-3°. Cabin temperatures, as could be expected, were more variable, but even so the variation was only in the region of 4°.

The two sets of graphs show only slight differences over the whole period—cabin temperatures were generally higher by 2°-3°.

Humidity.

Throughout the voyage relative humidity readings were regularly taken. A suitable position could not be found in the 'tween deck for the hygrograph but wet bulb readings were taken at the same times and positions as were the dry bulb readings. Table 4 sets out the results which are illustrated in Figure 3.

On Friday the 7th November, after leaving Geraldton, relative humidities were generally low, ranging from 52 per cent. to 59 per cent. on deck and from 62 per cent. to 69 per cent. in the 'tween deck. Subsequently a gradual increase took place until on the 15th the figures for all positions exceeded 80 per cent. all day. The highest reading was 86 per cent. recorded on Saturday 15th, on the forward deck at 9 a.m., 'tween deck at 3 p.m., and the after deck at 6 p.m.

During the day time the 'tween deck figures were greater than those on the other decks. For instance, at 12 noon the average 'tween relative humidity was seven per cent. higher than the forward deck and 12 per cent. higher than the after deck. At the other times, average 'tween relative humidities exceeded the other recordings as follows:—

	Fore.	Aft.
	%	%
9 a.m.	4	8
3 p.m.	7	9
6 p.m.	2	2
9 p.m.	equal	1

The relative humidity graphs show a converse trend to the temperature graphs. The after deck, which recorded the highest average day time temperatures, experienced the lowest daytime relative humidities. The forward deck, was intermediate with regard to temperatures, was also intermediate with regard to relative humidities.

After 9 a.m. each day average relative humidities, in all three positions, declined until noon and then gradually rose throughout the afternoon and evening. At 9 p.m. the average for each of the three decks was approximately 80 per cent.

The average relative humidity figures for all positions were as follows:—

	%
9 a.m.	73
12 noon	68
3 p.m.	72
6 p.m.	77
9 p.m.	80

TABLE 4.

RELATIVE HUMIDITIES, 7TH TO 16TH NOVEMBER, 1947.

Date.	Cabin.					Forward Deck.					'Tween Deck.					After Deck.				
	9 a.m.	12 noon.	3 p.m.	6 p.m.	9 p.m.	9 a.m.	12 noon.	3 p.m.	6 p.m.	9 p.m.	9 a.m.	12 noon.	3 p.m.	6 p.m.	9 p.m.	9 a.m.	12 noon.	3 p.m.	6 p.m.	9 p.m.
7th	63	64	63	63	....	....	55	59	58	....	....	62	63	69	....	....	52	57	....	....
8th	75	71	72	77	65*	71	....	65	74	68*§	75	....	71	77	72*§	64	....	62	71	....
9th	56	72	65	78	68	52	66	....	76	72§	66	76§	....	80	72§	51	....	....	71	....
10th	77	78	78	78	86	70	65	76	80	86	78	78	78	84	85	59	60	74	82	84
11th	83	....	75	....	83†	76	....	65	....	....	78	....	72	....	....	70	....	63	....	....
12th	79	75	79	75	83	70	71	75	79	83	74	76	77	79	83	66	63	69	75	....
13th	75	75	75	72	76†	68	67	66	75	77†	75	74	75	76	79†§	67	63	69	76	79†§
14th	78	79	76	76	75†	80	67	68	69	74†§	78	70	82	73	74†§	81	61	64	70	74†§
15th	82	82	82	82	74†	86	....	....	82	78†§	85	....	86	....	78†§	82	....	....	86	79†§
16th	78	83	74	79††	75†	....	79	74	....	....	84	78	....	....	....	....	....	73	....	....

* 10.0 p.m. † 10.30 p.m. †† 7.30 p.m. § Single readings.

A study of the cabin hygrograph record for the period 10th to 15th November, shown as Figure 6, reveals a divergence from the general information, but cannot be regarded as being accurate as this type of instrument is not considered reliable. The highest humidity recorded was 93 per cent. between 6 a.m. and 7 a.m. on Saturday, 15th November. During the first two days the peak occurred between 10 p.m. and 7 a.m. The lowest figures were recorded round mid-day. During the last three days the graph is erratic.

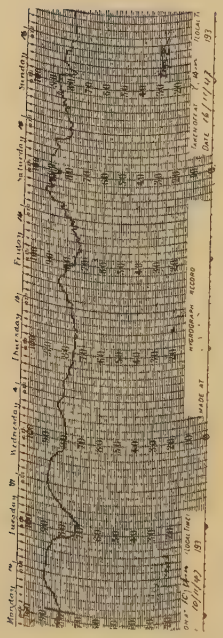


Figure 6.—Hydrograph—Cabin relative humidities—M.V. Charon.

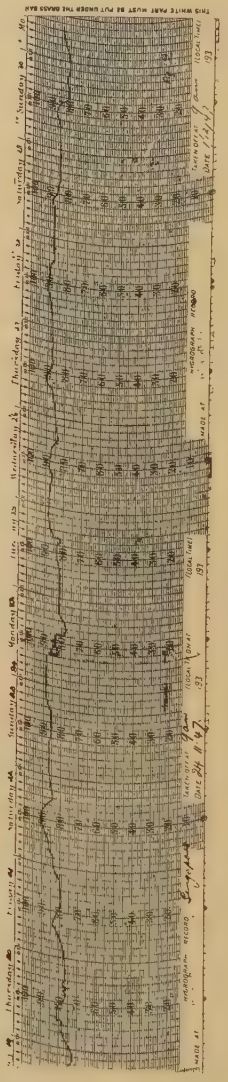


Figure 7.—Hydrograph—Conditions in Singapore.

Weather Data.

Though the courtesy of the First Officer, Mr. Vaughan, data covering wind force and direction were supplied.

Until the 8th when Onslow was reached, the vessel was sailing approximately due north. Thereafter to Broome the general direction was north-east. Broome was reached early a.m. on the 11th and departure for Singapore was made the following morning. The general direction taken to Singapore was then north-west.

Fairly good cross winds were experienced during most of the voyage, except towards the end when strong north-west head winds were encountered. The fruit stowed in the 'tween deck would be benefited by the ventilation provided by the passage of air through the open cattle ports.

Condition of Fruit.

Regular inspections of fruit were made during the voyage for the purpose of noting deterioration of any kind.

Several cases of Granny Smith apples, both in the 'tween deck and on the forward deck, were examined each day for the purpose of ascertaining the development of physiological disorders.

The chief defects which developed were:—Scald, yellowing and core flush.

Signs of scald in association with slight sunburn injuries were noticed on the second day after leaving Fremantle. The disorder progressively developed during the voyage and subsequently all fruit affected with sunburn became badly "scalded." Apples unaffected with sunburn did not scald.

The development of yellow colour was rapid with 2¾ inch apples, and to a lesser extent with the smaller sizes. The day following discharge of the fruit in Singapore the 2¾ inch were mostly YYY, the 2½ inch mostly GYY and 2¼ inch GY to GYY. The colour of the fruit in cases sampled was green when first seen.

The first signs of core flush were seen six days after leaving Fremantle and it developed steadily throughout the voyage. The larger sizes were most susceptible but the 2¼ inch in some instances were equally affected.

From examination of the orange stacks, odd oranges affected with mould, were noticed through the crevices of the cases in all parts of the ship where the fruit was stowed. During the last week of the voyage a few ullaged cases in the 'tween stack were inspected each day and apart from slight mould infection, the fruit maintained its good condition.

Lemons stowed in the 'tween, starboard side near the crew's quarters rapidly deteriorated due to mould infection. They were seen on the wharf subsequently and were in a very poor condition.

The stacks of tomatoes were watched for development of colour. They were loaded green; on arrival they were mostly GY with pink colour showing in a few instances.

Pulp temperatures of tomatoes taken at Geraldton averaged 72°F. Heavy rain on the last day of the voyage precluded a general inspection of the fruit cargo as had been planned with the ship's officers.

Conditions in Singapore.

During the period I was in Singapore the weather was warm and humid and heavy rain fell on a number of occasions. The average rainfall is 95 inches and average monthly falls vary between 6.62 inches and 10.55 inches. In the Cameron Highlands the average is 110.57 inches a year and the monthly falls range from 3.28 inches to 15.39 inches; the months of lowest rainfall are February, May, June, July and August.

Thermograph records of the temperatures experienced in the Hotel bedroom for the period 19th November to 5th December are shown in Figure 8. These temperatures provide some evidence of the conditions under which fruit is discharged from the ships in Singapore harbour and held in common storage on dealer premises at this time of the year.

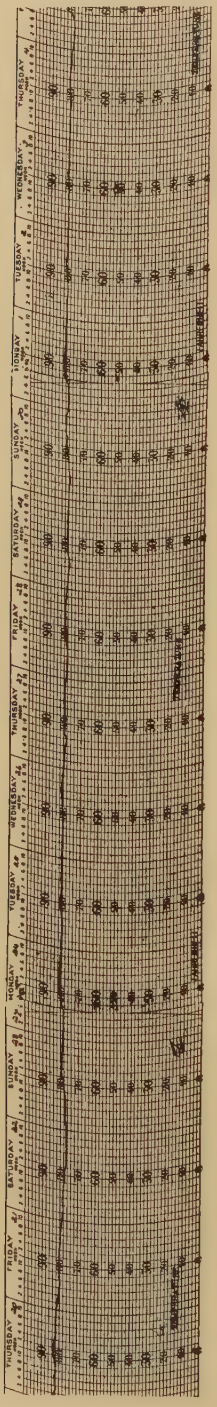


Figure 8.—Thermograph—Singapore temperatures.

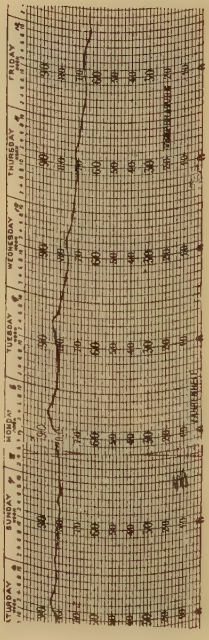


Figure 9.—Thermograph—Cabin temperatures—M.V. Gorgon.

It will be noticed that the average temperature was approximately 80°F day and night over the whole period. Daily fluctuations did not exceed 4°F On some occasions maximum and minimum day-time temperatures did not vary by more than 1°F.

The hygrograph was also set up in the Hotel bedroom and the records for the period 19th November to 1st December are shown in Figure 7.

The range of relative humidities recorded over the period was 23 to 91 per cent. with an approximate average of 85 per cent. Peaks occurred mainly between 9 a.m. and midday.

The readings were checked with a hygrometer each day, and it was found that the hygrograph records were generally 6 per cent. higher than the readings obtained by the wet and dry bulb thermometers.

Thermograph records are shown in Figure 9 of the temperatures experienced in the cabin on the return voyage to Fremantle on the M.V Gorgon—6th December to 13th December.

The highest temperature was 86°F on the 8th December. Thereafter there was a gradual decline until Fremantle was reached on the 13th December when the temperature was 64°F.

ACKNOWLEDGMENTS.

On board ship every facility for collecting the necessary information was provided by Captain Marriott and Mr. Vaughan, the First Officer. Mr. Lewington by his interest and co-operation enabled the necessary approaches to be made to the Captain of the vessel.

Mr. J. Hogan, of the Weather Bureau, was particularly helpful and by his constructive criticism of the draft some errors were rectified.

Mr. T. C. Miller of the Department also materially assisted in obtaining the equipment, in making suggestions as to how the information was to be collected and by helpful discussions of the assembled data.

Appreciation is expressed for the service rendered by Mr. F. Melville in assisting with the preparation of this article for publication.

INFLUENCE OF MONTH OF CALVING ON PRODUCTION.

OFFICIAL PURE BRED HERD RECORDING.

R. A. BETTENAY, Agricultural Adviser.

IN a recent Journal (Vol. XXV No. 4, Dec. 48) the average production of cows tested under the Dairy Herd Improvement Scheme, according to month of calving, was shown. This study emphasized the importance of freshening cows during the five monthly period from March to July under the normal system of management practised with grade herds in this State whereby the cow relies largely on pasture as a source of supply of food materials and little feeding of concentrates is carried out. The present article records the results of a similar study of the production records of cows tested under the Official Australian Pure Bred Dairy Cattle Recording Scheme.

Testing under this scheme was commenced in 1918 so that production records are available for the thirty-two years 1918-49 inclusive. In this study the thirty-two year period was initially divided into the four sub-periods 1918-29, 1930-39, 1940-44, and 1945-49 in order to determine any changes that had been made over the whole period.

The State was divided into four arbitrary divisions as follows:—

(a) METROPOLITAN—extending from Pinjarra in the South to Gingin in the North and Eastwards to include Wooroloo.

(b) SOUTH WEST—extending Southwards from Pinjarra and Eastwards to include Nornalup.

(c) SOUTH COASTAL—including Albany, Denmark and surroundings.

(d) GREAT SOUTHERN and WHEATBELT—a large district comprising those parts of the State not included in a, b or c.

Further, the three breeds Jersey, Guernsey and A.I.S. were considered separately, so that the investigation included four sub-periods of time, four districts and three breeds, or a total of forty-eight subdivisions.

All lactations of 150 days or more were included in the averages. It became apparent as the study progressed that so much subdivision was not warranted due to the small number of cows freshening in some months, and to the very great variation in production of individual lactations. (Range between greatest and least lactation over 600 lb.)

To increase the numbers in each subdivision the three breeds were combined since it was apparent that any trend in total production according to month of calving was very similar for each of the three breeds. The subdivisions of time were then combined to two periods 1918-39 and 1940-49 since there appeared to be no definite trend over the years.

Production according to month of calving in each of the four districts being considered is shown in Table 1 together with the number of lactations on which each average is based. A further column combines the four districts to give an average production according to month of calving for all pure-bred cows tested in this State. The same results are shown in different form in Graph No. 1.

It will be observed from Table 1 and the accompanying graph that there is no very definite trend in monthly production throughout the year. In individual districts there is often considerable variation between the production in one month and the next and this may be explained as caused by the large variation between individual lactations and the comparatively small number of lactations in the averages. There is, however, in districts *a*, *b* and *c*, a tendency for production in the months January, February, November and December to be lower than in the intermediate months. In district *d*, (Great Southern and Wheatbelt) month of calving appears to have had no significant effect on production. The difference between districts *a*, *b* and *c*, on the one hand and district *d* on the other may be due to a greater feeding of concentrates in the latter district which is outside of the true dairying zone. It would also suggest that within the limits set by breeding, food supply is the important factor in determining total production and that other environmental conditions such as temperature are seldom limiting under conditions which exist in the South-West of this State. This is further borne out by the results obtained in certain individual herds where excellent production is obtained from cows freshening in all months of the year.

GRAPH No. 1.—PRODUCTION ACCORDING TO MONTH OF CALVING—COMPARISON OF DISTRICTS.

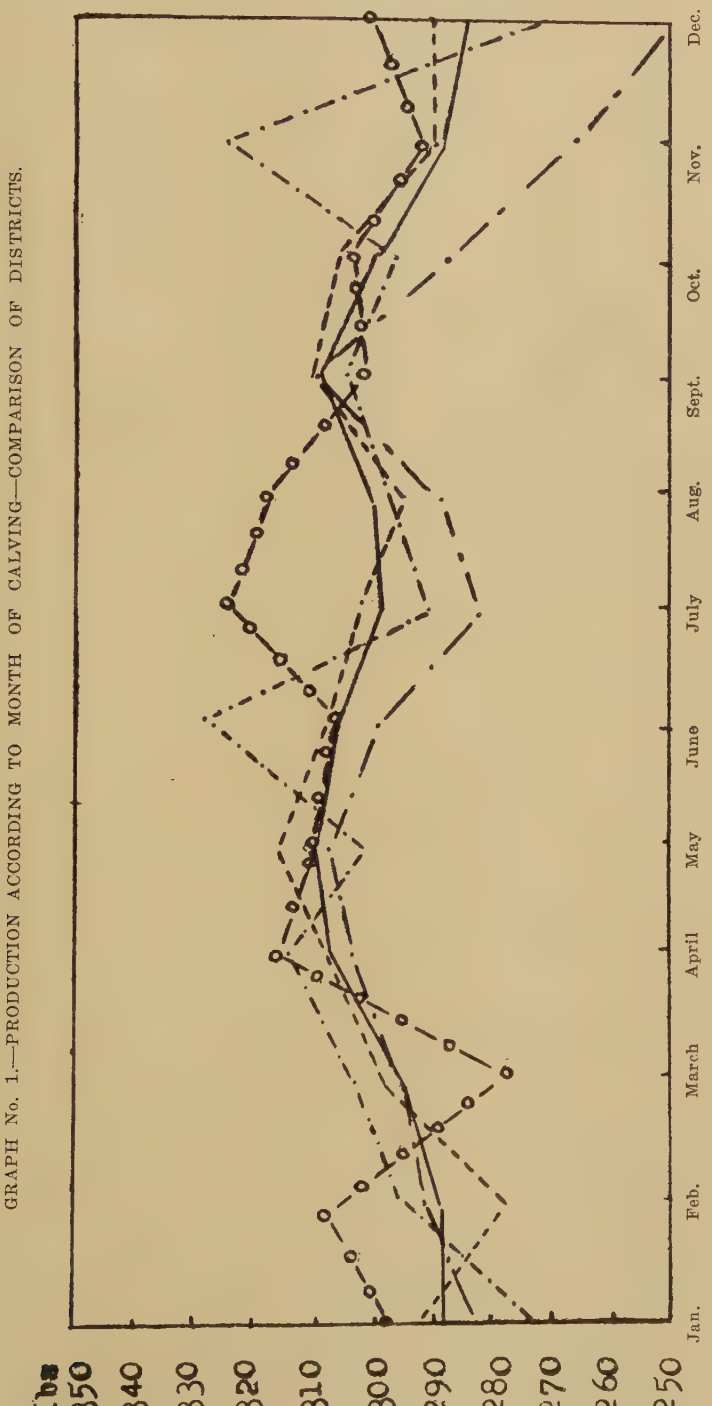


TABLE 1.

AVERAGE PRODUCTION ACCORDING TO MONTH OF CALVING BY DISTRICT.

Month of Calving.	District.									
	Metropolitan (*a*)		South-West (*b*)		South Coastal (*c*)		Great Southern (*d*)		All Districts.	
	No. of Lactations.	Average Production.	No. of Lactations.	Average Production.	No. of Lactations.	Average Production.	No. of Lactations.	Average Production.	No. of Lactations.	Average Production.
January	118	291·1	58	282·7	27	274·5	53	299·6	256	288·6
February	131	278·3	86	291·0	30	295·6	78	307·2	325	287·3
March	197	299·1	189	295·2	52	302·1	121	277·9	559	293·5
April	197	307·8	286	302·2	54	312·8	157	313·8	694	307·0
May	221	316·7	422	308·1	69	301·7	208	308·9	920	309·8
June	200	308·0	390	299·7	97	327·0	188	307·3	875	306·2
July	229	302·9	365	283·5	85	290·2	170	322·0	849	297·1
August	299	295·4	411	289·3	91	301·7	213	317·6	1,014	298·2
September	286	310·7	296	310·2	90	305·4	170	298·7	842	307·6
October	262	306·4	182	287·2	78	295·9	104	303·2	626	299·0
November	161	288·1	120	264·9	59	324·3	73	292·8	413	287·3
December	198	289·7	64	245·8	39	273·1	61	301·5	362	282·2

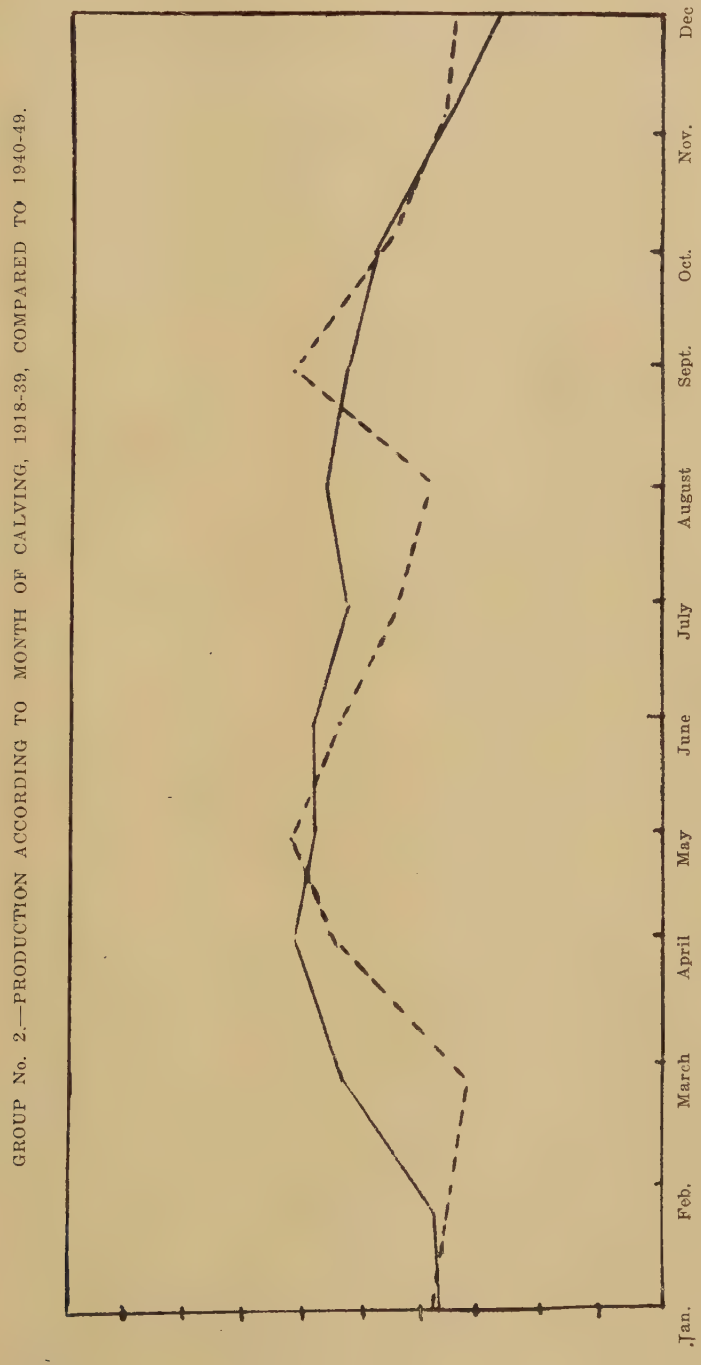
TABLE 2.

AVERAGE PRODUCTION ACCORDING TO MONTH OF CALVING.

1918–39 *compared to* 1940–49.

Month of Calving.	1918–39.		1940–49.	
	No. of Lactations.	Average Production.	No. of Lactations.	Average Production.
January	138	287.9	118	289.4
February	165	288.8	160	285.8
March	279	305.9	280	281.1
April	322	311.2	372	303.3
May	448	308.1	472	311.5
June	403	308.2	472	304.6
July	380	303.0	469	292.4
August	502	306.6	512	289.8
September	432	303.9	410	311.4
October	311	299.5	315	298.6
November	208	284.9	205	289.7
December	159	276.2	203	286.8
Average	3,747	302.1	3,988	297.7

Production in the two periods 1918-39 and 1940-49 is compared in Table 2 and Graph No. 2. It is apparent that there has been no change in production according to month of calving between the two periods. The same appears to hold when the sub-periods are further divided to give the four sub-periods mentioned previously. Unfortunately the number of tested lactations in the period 1918-29 is too small to permit conclusions being reached regarding the trend of production according to month of calving for this period. It will also be observed that total production has not materially altered although it must be emphasised that this refers to production of cows tested and may not reflect the position in the industry as a whole.


GROUP No. 2.—PRODUCTION ACCORDING TO MONTH OF CALVING, 1918-39, COMPARED TO 1940-49.
lbs.
350
340
330
320
310
300
290
280
270
260
250
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec
1918-39.
1940-49.

As mentioned previously Tables 1 and 2 are based on all lactations of 150 days, or longer. This is the standard method adopted to determine the average production of a number of lactations: Those lactations which do not continue for 150 days are eliminated and all lactations which run for 150 days or more are considered, whatever the reason for discontinuance at a later date. While sound enough as a general rule, this is a major cause of the great variation between largest and smallest productions in a single lactation. In Table 3 and Graph No. 3 lactations completing the full 273 day period are compared with the average of all lactations. It will be seen that eliminating all lactations of less than 273 days has not affected the overall trend. By decreasing the variation it has however given a slightly smoother curve to the graph. It will be noticed that in all months the average of 273 day lactations is from 16-25 lb. higher than the average of all lactations, and over the 12 months averages 17.8 lb. higher.

TABLE 3.

273 DAY PRODUCTION COMPARED TO PRODUCTION OF ALL LACTATION.

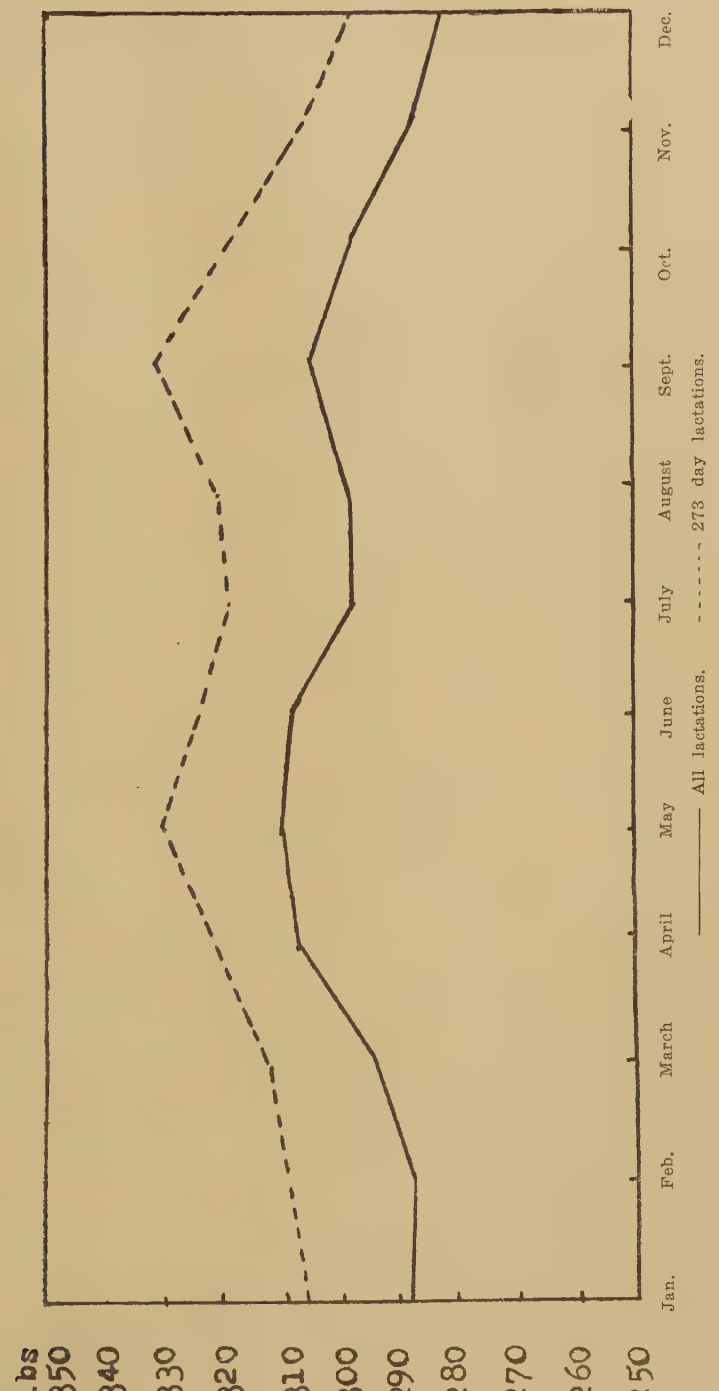
Month of Calving.	273 Day Lactations.		All Lactations.		Percentage of Lactations Completing 273 Days.
	No. of Lactations.	Average Production.	No. of Lactations.	Average Production.	
January	218	306.0	256	288.6	85.2
February	262	309.2	325	287.3	80.6
March	457	312.5	559	293.5	81.7
April	586	323.7	694	307.0	82.9
May	738	331.7	920	309.8	80.2
June	685	323.4	875	306.2	78.3
July	636	319.6	849	297.1	74.9
August	789	322.6	1,014	298.2	77.8
September	682	332.8	842	307.6	81.0
October	499	319.4	626	299.0	79.7
November	333	305.7	413	287.3	80.6
December	255	300.3	362	282.2	70.4
Total	6,140	317.6	7,735	299.8	79.4

A further column has been added to Table 3 showing the percentage of all lactations which complete a 273 day period. There is no trend according to month of freshening the highest being 85 per cent. in January and the lowest 70 per cent. in December, average 79.4 per cent.

It will be further seen from Graph No. 3 that there are two peaks in total production according to month of freshening. The significance and importance of this cannot be determined until further testing has been carried out in years to come. It cannot be explained as caused by a May peak in one district and a September peak in another district as will be seen by study of Graph No. 1 which shows the production of individual districts. Until further lactation records are available for study, all that can be said is that cows which freshen in the intermediate months of the year are likely to produce more than cows which freshen at either end of the year, under the average conditions existing in pure bred herds in this State.

The spread of calvings throughout the year can be readily seen by study of Table 1. It will be observed that there is a definite tendency towards freshening cows in the intermediate months of the year although the spread is

GRAPH No. 3.—COMPARISON ALL LACTATIONS AND 273 DAY LACTATIONS.



much greater than is found in grade herds and the peak is several months later. In grade herds it was found that 78 per cent. of all lactations commence in the five monthly period March-July; this investigation showed that only 50 per cent. of pure bred cows under test are freshened in this period and that 67 per cent. are freshened in the six months from April to September. Study of Table 2 will show that the spread of calvings throughout the year is materially the same in the period 1940-49 as in the earlier period 1918-39. Thus it is seen that the spread of calvings throughout the year is not only very similar from one district to another but is also constant throughout the years.

SUMMARY.

Production according to month of calving was studied for all cows tested under the Official Australian Pure Bred Dairy Herd Recording Scheme over a period of 32 years, the State being divided into four districts. It was found that production of cows freshened in January, February, November and December tended to be lower than that of cows freshened in the intermediate months of the year. The trend in the early years of testing was found to be similar to that in the last decade. Differences in production according to month of calving were slight when compared to those found in grade herds in a previous study.

Production from lactations completing 273 days is compared to production from all lactations.

Results are discussed and the conclusion reached that, within the limits set by breeding, feed is the limiting factor to production of cows in the South West of this State.

FERTILISER TRIALS ON ANNUAL PASTURE.

WOKALUP RESEARCH STATION.

M. CULLITY, SUPERINTENDENT OF DAIRYING. H. G. ELLIOTT AGROSTOLOGIST.

INTRODUCTION.

THE Australian Dairy Produce Board Pasture Improvement Committee (W.A.) is comprised of two representatives of dairy produce manufactures, three dairy farmers and the Superintendent of Dairying.

It derives its funds from the Australian Dairy Produce Board and the Rural Credits Branch of the Commonwealth Bank.

Although the Department of Agriculture does not contribute directly to the Committee's funds, expenditure is incurred in carrying out the various projects on its behalf.

The grant from the Rural Credits Branch of the Commonwealth Bank is on a £1 for £1 basis with the expenditure by the Department with a maximum of £250 per annum.

The Committee has approved of a number of pasture demonstrations and experiments in recent years and has also sponsored various competitions with pasture. fodder conservation and farm management. Its endeavours are to create a " pasture conscience " amongst farmers and to help in obtaining advances in pasture establishment and management.

The following reports are on projects conducted for the Committee at the Wokalup Research Station.

Similar trials are being conducted at Denmark, Manjimup, Mt. Barker, Margaret River and Byford on winter pastures, while other experiments have been completed on irrigated pastures at Harvey and Waroona.

PART I.—Rate and Time of Application of Superphosphate to Winter Type Pasture.

SUMMARY.

This experiment was carried out during the five seasons 1943–47.

Superphosphate was applied as one dressing in the autumn at rates equivalent to from 0 *to* 6 *cwts. of* 23 *per cent. phosphoric acid super. per acre while up to four cwt. per acre were also used in two dressings, one in autumn and another in spring.*

Data is presented relating to—

(*a*) *The yields per acre as tons green, air dried, and dried at* 80° *C.*

(*b*) *Botanical analyses giving clover percentages and yields.*

(*c*) *Chemical analyses for nitrogen phosphorus and calcium for five years and potassium for three years.*

(*d*) *Rainfall data for growing periods during the five years.*

The results show that an application of two cwts. of superphosphate per acre in the autumn was the most economic. Applications in excess of this amount did not give any significant increase. No advantage followed the application of part of the fertiliser in the autumn, and part in the spring.

The subterranean clover and grass balance were maintained throughout the trial under all superphosphate treatments.

OBJECTIVE.

The object of the experiment was to obtain information regarding the response of mixed subterranean clover pasture to varying rates of application of superphosphate and to ascertain whether it was better to apply fertiliser in the autumn or portion in the autumn and the remainder in the spring.

It was planned to obtain this information by determining :—

(a) The yields of green and dry material, phosphorus, nitrogen, potassium and clover produced per acre resulting from autumn applications of 23 per cent. phosphoric acid superphosphate at rates varying from 0 to 6 cwts. per acre.

(b) The yields of green and dry material, phosphorus, nitrogen, potassium and calcium and clover produced per acre resulting from applications of 23 per cent. phosphoric acid superphosphate when applied in the autumn and spring.

(c) The effect of autumn dressings of 1, 2, 3 and 4 cwts. of 23 per cent. phosphoric acid super. per acre applied in the autumn compared with similar quantities applied in two dressings, one in autumn and one in spring.

RAINFALL.

Table I. (attached) gives the rainfall figures for Harvey for the growing period for the five years 1943–47, together with the average rainfall in months for the five years and the average month's fall over a period of 45 years.

It will be seen from this Table that the amount of rain which fell during the growing period varied from 28 inches to 53.36 inches. The two years, 1945 and 1947, were above average and the results of the yields obtained during those years varied somewhat from the other three years.

In 1944 and 1946 very little rain fell after the spring application of super. and it is debatable if there were sufficient to fully utilise the fertiliser or even to wash it completely off the leaves.

TABLE 1.

MONTHLY RAINFALL FIGURES FOR YEARS 1943–47.

Falls in Inches as Registered at Harvey (3 miles North of Wokalup).

Month.	Years.					Average Fall in Month for 5 Years.	Average Fall in Month for 45 Years.
	1943.	1944.	1945.	1946.	1947.		
April	1.93	.91	.43	.93	3.09	1.46	1.78
May	3.64	5.98	11.81	8.39	12.12	8.39	5.63
June	5.80	4.98	18.43	7.88	13.78	10.17	8.00
July	6.04	8.22	6.44	15.80	5.24	8.35	7.97
August	4.66	4.34	9.99	4.97	3.62	5.52	6.07
September	6.08	1.49	4.29	1.33	3.41	3.32	4.41
October	.35	.82	.83	.15	3.52	1.13	2.85
November	.06	1.28	1.14	.33	.44	.65	1.03
Total for growing period	28.56	28.02	53.36	39.78	45.22	....	....
Average for five years for growing period	....	....	....	....	....	....	36.99
Annual Average for growing period	....	....	....	....	....	....	37.74
Total for year	34.32	30.59	55.71	44.67	46.82	....	....
Annual Average 45 years	40.00	....	....	....	....	....	40.00

EXPERIMENTAL.

(1) *Materials and Methods—*

(a) Area and botanical cover.

An area of three acres was selected carrying subterranean clover as the dominant species, and evenly over the area. In addition the following grass species were present: festuca, bromus, lolium, and some cynodon-dactylon. Weeds were not present in serious proportion although a few plants of cape weed and flat weed were present.

It is believed that at least 25 cwts. per acre of superphosphate had been applied to the paddock during the 15 years prior to the commencement of the experiment. In the years immediately prior to this trial, the paddock was used as pasture and for two crops of flax. Earlier occasional oat crops broke the sequence of use as pasture.

(b) Soil.

The soil is slightly podsolised with talus material as parent rock. The profile was—

Inches.	
0– 4	Yellowish brown loam with organic matter. Structure—large crumb.
4–22	Yellow clay loam plus small decayed gravel particles (few).
22–33	Brown and yellow mot, clay plus partially decayed pieces of grave, gneiss, granite, also quartz lumps. Structure—nutty to massive.
36–45 and on	Greyish brown, yellow brown and white (dull shades) mottled heavy clay and plus pieces of gneiss and other rocks. Structure—massive

2. *Design and Treatments.*

The twelve treatments shown in Table 2 were replicated six times in a randomised block system.

TABLE 2.

Treatments.

Series.	Rates of Superphosphate per acre.		
	Autumn cwt.	Spring cwt.	Total cwt.
A	0	0	0
B	1	0	1
C	2	0	2
D	3	0	3
E	4	0	4
F	5	0	5
G	6	0	6
H	0	1	1
J	1	1	2
K	1	2	3
L	2	1	3
M	2	2	4

3. *Botanical Analysis.*

A botanical analysis of the plots was carried out in May, 1943, prior to the first application of fertiliser. Five counts of subterranean clover plant on four square link areas were made on each plot. The number of plants per square link is shown in Table 3.

TABLE 3.

Number of Subterranean clover plants per square link.

Series.	Treatments cwts. super. per acre.		Subterranean clover plants per square link.	
	Autumn.	Spring.	Total.	Mean.
A	0	0	224.0	37.3
B	1	0	208.4	34.7
C	2	0	230.7	38.4
D	3	0	272.6	45.4
E	4	0	253.2	42.2
F	5	0	226.8	37.8
G	6	0	269.4	44.9
H	0	1	238.8	39.8
J	1	1	236.4	39.4
K	1	2	245.0	40.8
L	2	1	250.9	41.8
M	2	2	252.6	42.1
		Mean	242.4	40.4
		Range	34.7 to 45.5 link.	plants per sq.

At the time the above analyses were made the germination of subterranean clover plants was still taking place and it was anticipated that the final number of clover plants per square link would be greater.

Although grass species such as silver, brome, rye and couch were present in appreciable amounts, weeds on the area were not serious.

The population of clover plants on the area was considered good and as uniform as could be expected.

4. *Superphosphate.*

At the commencement of the experiment in 1943, 23 per cent. phosphoric acid superphosphate was used, the origin of the rock being Nauru. Since 1943 the rock came from North Africa and the phosphoric acid content varied from 18 to 20 per cent. but each year the amount applied was increased to give the equivalent to 23 per cent. phosphoric acid.

The dates of application were :—

	Autumn.	Spring.
1943	29th March	6th September
1944	17th April	23rd August
1945	11th April	27th August
1946	8th April	21st August
1947	29th April	14th August

5. *Grazing, Mowing and Sampling.*

No grazing of the area was carried out during the growing period. The only grazing given was during the period when the pasture was dry.

The plots were harvested by means of a mower at the hay cutting stage, the dates being as follows :—

10th November, 1943, 2nd November, 1944 ; 6th November, 1945 ; 6th November 1946 ; 24th November, 1947.

The gross weight of each plot was recorded and a sample weighing four pounds taken.

After air drying all samples reprsenting each separate treatment were bulked, and two further samples taken therefrom, being composite samples representing all plots in each treatment. One of these was used for botanical segregation to determine the proportions of clover, and the other subjected to chemical analysis.

RESULTS.

1. *Yields.*

Table 4 summarises the complete results for all treatments and gives the mean averages for five years of yields of green, dry, and air dried material per acre, the percentage and yield of clover and grass and the nitrogen, phosphorous, calcium and potassium percentages and weight in pounds per acre.

Comments on the yearly average yield of air dried material obtained in cwts. per acre from the various treatments are as follows :—

(a) The yield from the application of 1 cwt. per acre was 9.8 cwts. more than from the plots receiving no superphosphate.

(b) Two cwts. per acre of superphosphate gave 5.2 cwts. more than the one cwt. applications.

(c) Two cwts. per acre of superphosphate gave 15 cwts. more than the on fertiliser plots. This is equal to 7.5 cwts. for each one cwt. of superphosphate used.

(d) Applications of three, four, five and six cwts. of superphosphate gave no significant increase in yields.

(e) There was an increase of three cwts. from the six cwts. compared to the two cwts. superphosphate treatments, but owing to the seasonal and plot variations this increase cannot be considered significant.

(f) The yields from the two cwt. superphosphate treatments were slightly superior over the period of the experiment than any treatment where second applications of superphosphate were made in the spring, following one or two cwts. in autumn. However, plot and seasonal variations make this higher yield without significance. Conversely there is significance in the regular failure of spring applications to stimulate additional growth over that obtained from an application of two cwts. in the autumn (see Table 4 and graph 1).

TABLE 4.
YIELDS OF HERBAGE.

Symbols.	Treatments. Super. Applns. Applied.		Yields.			Moisture lost from Air dry.
	Autumn.	Spring.	Green.	Air Dry.	Dried 80°C.	
	Cwt./acre.	Cwt./acre.	Tons/acre.	Tons/acre.	Tons/acre.	%
A	0	0	5.61	2.09	1.84	11.5
B	1	0	8.18	2.58	2.25	13.0
C	2	0	8.52	2.84	2.48	12.0
D	3	0	8.91	2.83	2.48	12.0
E	4	0	8.90	2.89	2.50	13.0
F	5	0	9.03	2.84	2.49	12.0
G	6	0	9.38	3.00	2.63	12.1
H	0	1	7.75	2.43	2.12	12.5
J	1	1	8.26	2.63	2.31	12.0
K	1	2	8.23	2.72	2.38	12.5
L	2	1	8.32	2.79	2.45	11.9
M	2	2	8.84	2.72	2.38	12.5
S/E of Treatment mean Tons/acre			....	.081	....	....
Least sign. diff. Tons/acre at 5%			....	.23	....	....
,, ,, ,, 1%			....	.31	....	....

2. *Botanical Composition.*

From the samples cut from the individual plots, composite samples for each treatment were made each year. These were segregated in order to determine the proportion of subterranean clover present, and the details are given in Table 5. These show that the yield of clover was increased by every application of superphosphate compared with the plots where none was used. The gross weight from the latter treatment over the five years was 96.2 cwts. of air dried material compared with 161.7 and 152.1 cwts. respectively from the five cwt. and the six cwt. treatments. These represented the highest yield for the treatment.

TABLE 5.
BOTANICAL COMPOSITION.

Symbols.	Treatments. Super. Applns. Applied.		Composition.			
	Autumn.	Spring.	Clover.	Grass.	Clover.	Air Dry Grass.
	Cwt./acre.	Cwt./acre.	%	Tons/acre.	Tons/acre.	Tons/acre.
A	0	0	46.0	54.0	.96	1.13
B	1	0	43.3	56.7	1.11	1.47
C	2	0	43.9	56.1	1.24	1.60
D	3	0	48.0	52.0	1.36	1.47
E	4	0	43.9	56.1	1.26	1.63
F	5	0	57.0	43.0	1.61	1.23
G	6	0	50.6	49.4	1.52	1.48
H	0	1	49.8	50.2	1.21	1.22
J	1	1	50.4	49.6	1.32	1.31
K	1	2	54.0	46.0	1.46	1.26
L	2	1	47.7	52.3	1.33	1.46
M	2	2	48.6	51.4	1.32	1.40

3. *Chemical Composition Table* 6.

A division of the composite sample for each treatment for each year was made and a sub-sample was forwarded to the Government Chemical Laboratories for determination of nitrogen, phosphorus and calcium.

For the years 1944–5 to 1945–6 and 1946–7, analyses for the potassium content were carried out also.

(a) Phosphorus.

The average percentage of phosphorus on a dry weight basis and the total weight which is equivalent to the amount withdrawn from the soil is shown in Table 6. It will be noted that there is a progressive increase in both the percentage and the total withdrawal of phosphorus as the rate of application of superphosphate increased.

There was an increase in the percentage of phosphorus where a second application of superphosphate was given in spring but there was no appreciable increase in the total amount contained in the herbage.

(b) Nitrogen.

There was no increase in the percentage of nitrogen in the one and two cwt. treatments compared to no fertiliser, but the proportion from the five and six cwt. treatments was slightly higher.

The greater bulk from the two cwt. plots caused the total quantity of nitrogen to be higher than in the no fertiliser treatment.

The total quantity of nitrogen from the five and six cwt. treatments was higher than from the two cwt. plots.

No improvement in the total yield of nitrogen can be seen where autumn and spring applications were given.

(c) Calcium.

There appeared to be an increase in the proportion of calcium and the total taken up from the soil were five and six cwts. were applied. Some small increase also resulted from spring applications.

(d) Potassium.

The analyses for potassium were carried out in three years of the experiment only. There is no indication of any variation in the percentage nor the total uptake of this element.

TABLE 6.

CHEMICAL COMPOSITION OF ASH OF HERBAGE.

Symbols.	Treatments. Super Applns. Applied.		Analysis on Dry Basis.							
	Autumn.	Spring.	N.	P.	Ca.	K.	N.	P.	Ca.	K.
			%	%	%	%	Lbs./ acre.	Lbs./ acre.	Lbs./ acre.	Lbs./ acre.
A	0	0	2.03	.134	.86	1.38	83.36	5.52	35.45	42.9
B	1	0	1.94	.166	.85	1.32	97.65	8.21	42.64	51.9
C	2	0	1.88	.198	.78	1.19	104.2	11.04	43.61	50.1
D	3	0	2.13	.222	.89	1.21	117.92	12.3	49.29	50.5
E	4	0	1.92	.241	.88	1.30	107.9	13.53	49.02	54.7
F	5	0	2.23	.244	.95	.99	124.86	13.61	53.06	38.7
G	6	0	2.15	.263	.95	1.08	126.3	15.54	56.29	47.8
H	0	1	2.02	.187	.90	1.20	96.78	8.95	43.15	45.9
J	1	1	2.03	.218	.90	1.16	104.42	11.26	46.56	45.4
K	1	2	1.98	.251	.94	1.42	105.84	13.45	51.46	58.9
L	2	1	2.02	.239	.95	1.30	111.86	13.16	50.82	53.3
M	2	2	2.26	.257	1.00	1.30	121.06	13.74	53.22	53.9

DISCUSSION.

The application of superphosphate to pastures in Western Australia is a universal practice. The quantity applied varies according to district ; the rates in the heavy rainfall districts (on winter pastures) in which dairying is a major activity range from about ¾ to 2 cwt. per acre. Statistical reports indicate that the average application is approximately 120 lbs per acre.

Earlier unreported trials supported by observation suggested that the average application was lower than the optimum. Opinions formed on these trials were the basis for advising farmers that higher applications would be economical and generally two cwts. per acre are recommended. This was frequently translated to the farmer's practical measure of one bag (187 lbs) per acre. There was no reliable data to indicate whether higher applications would be profitable. A few farmers in the development stage of their farms appeared to gain an advantage from using higher quantities but in succeeding years the response measured by observation of pastures, from carrying capacity, or from output of produce was less obvious. In other words the evidence for and against higher rates was conflicting.

The data procured in the experiment has clarified this position, as it shows that the autumn application of two cwts. of superphosphate gave the most economical yields. The greatest increase per cwt. was from the one and two cwt. applications.

While some of the results from rates from three to six cwt. suggested a slightly higher yield, the figures are not considered significant. Even if these were acceptable, the amount of increase would not repay for the cost of the additional applications.

An improvement in the proportion of clover in the pasture was recorded as rates were increased up to three cwts. and this was accompanied by an increase in the total nitrogen. This is important as it confirms the importance of increasing the level of application to two cwts. not only in order to get greater yields but herbage of higher nutritive quality, particularly in respect to its protein.

The higher applications did not result in any advantage, either in respect to bulk or the proportion of clover over the two cwt. treatments, and therefore, it may be concluded that from the aspect of yield and maintenance of the clover the optimum application in the conditions of this trial was two cwt. per acre.

There are interesting possibilities however, in the higher nitrogen, phosphorus and calcium uptake recorded for the higher dressings.

It may be that there is an advantage in using higher applications because of the better protein and mineral contents of the pastures. It is probable, however, that the supply of mineral licks would be more economical in supplying animal requirements. In any case with a prolonged period of annual topdressing with superphosphate the mineral composition of our pastures will probably rise. There is some evidence that this has occurred.

Some farmers still follow the practice of with-holding some of the superphosphate purchased in autumn for application in the spring usually on paddocks intended for hay. Others refrain from ordering their full requirements in the autumn and get the balance for spring topdressing. This practice has lessened in recent years but considerable interest is still maintained as to the economics of the practice. The present trial has shown that there is no advantage in dividing applications up to four cwt. instead of applying two cwt. in the autumn. This result was obtained with yields, botanical and chemical composition, with the exception that there appeared to be an improvement in the calcium with spring dressings. When the additional expense and wastage of time involved in giving the second dressing is considered it will be realised that the second dressing is unprofitable.

CONCLUSION.

The results show that under conditions of this experiment the optimum rate of application of superphosphate of winter pastures of subterranean clover and mixed grass is two cwts. of superphosphate per acre. The gain by applying two instead of one was appreciable. There was no advantage from applying the fertiliser in both autumn and spring.

PART II.—An investigation to study the residual effect of superphosphate in years subsequent to application on subterranean clover-grass pasture.

SUMMARY.

An experiment to obtain information regarding the residual effect of superphosphate applied to subterranean clover-grass, annual type pasture was conducted during the period 1943–47. *Details of yields from plots to which no superphosphate had been applied over one, two, three, four and five years compared to which the equivalent of two cwt. of* 23 *per cent. phosphoric acid superphosphate had been applied annually are presented.*

It was concluded that following several annual applications of superphosphate to pasture in adequate amounts, the omission of a dressing in one year caused only a slight decline in yield. However, in view of the varying soil types present in the dairying district and the fact that the phosphate status of many pasture soils has not as yet been sufficiently built up, the omission of fertiliser in any year is not recommended.

Replications of each treatment were five in number, and the design of the experiment was of the randomised block type.

Climate, soil, pastures and time of cutting were similar to those for the experiment described in Part 1 of this report.

Detailed results are presented of the following :—

(a) *Green, air dry and dried at 80° C. yields of herbage.*

(b) *Botanical analyses.*

(c) *Chemical analyses showing the percentages and the rates of withdrawal in pounds per acre of nitrogen, phosphorus and calcium for five years and potassium for three years.*

OBJECTIVE.

The experiment was designed to measure the residual effect of superphosphate over one, two, three, four and five years by determining the comparative yields both green and dry weights, together with analyses for phosphorus, nitrogen, potassium and calcium from areas to which no superphosphate had been applied for varying periods up to five years, following one or more annual applications at the rate of two cwt. per acre, by—

(a) determining the yields of green and dry material, clover, phosphorus, nitrogen, potassium and calcium per acre from Autumn applications of superphosphate at the rate of two cwt. per acre over one, two, three, four and five years.

(b) Comparing the residual effect on plots to which no superphosphate had been applied for one, two, three, four and five years.

EXPERIMENTAL.

1. *Rainfall—Location, etc.*

As the trial was conducted in the same paddocks as that reported in Part 1 the information contained therein referring to rainfall, soil, prior history, botanical composition, fertiliser, grazing, cutting and sampling may be taken as referring also to this report.

2. *Design and treatments.*

Five series of treatments were included plus a control series receiving two cwt. of superphosphate each year. Each was replicated five times in a randomised block design. Details of the treatments are given in table 7.

TABLE 7.

SUPER PER ACRE.

Treatment.	1943.	1944.	1945.	1946.	1947.
	cwt.	cwt.	cwt.	cwt.	cwt.
A	0	0	0	0	0
B	2	0	0	0	0
C	2	2	0	0	0
D	2	2	2	0	0
E	2	2	2	2	0
F	2	2	2	2	2

RESULTS.

1. *Yields.*

Details of the amount of herbage, the botanical composition, and chemical analyses, together with the gross withdrawal of the main elements are presented in tables 8, 9 and 10. All figures relate to the average for the five year period

TABLE 8.
YIELDS OF HERBAGE.

Symbols.	Treatments.		Yields Yearly.			Moisture lost.
	Years with Super. 2 cwt. per year.	Years without Super.	Green.	Air Dry.	Dried 80°C.	
			Tons/acre.	Tons/acre.	Tons/acre.	%
A	Before 1943	1943–47	4.98	2.00	1.78	11.0
B	1943	1944–47	5.7	2.05	1.82	11.0
C	1943–44	1945–47	6.62	2.23	1.98	11.0
D	1943–45	1946–47	6.69	2.29	2.07	9.5
E	1943–46	1947	7.35	2.56	2.26	12.0
F	1943–47	Nil	7.51	2.43	2.14	12.0
S/E of Treatment mean Tons/acre			....	.101	....	....
Least Sign. Diff. Tons/acre at 5%			....	.301	....	....
" " " 1%			....	.41	....	....

TABLE 9.
COMPOSITION OF HERBAGE.

Symbols.	Treatments.		Composition.			
	Years with Super. 2 cwt. per year.	Years without Super.	Clover.	Grass.	Clover.	Air Dry Grass.
			%	%	Cwt./acre.	Cwt./acre.
A	Before 1943	1943–47	41.0	59	16.4	23.6
B	1943	1944–47	42.3	57.7	17.3	23.7
C	1943–44	1945–47	45.4	54.6	20.2	24.4
D	1943–45	1946–47	48.0	52.0	22.0	23.8
E	1943–46	1947	44.5	55.5	22.8	28.4
F	1943–47	Nil	49.2	50.8	23.9	24.7

TABLE 10.
COMPOSITION OF ASH OF HERBAGE.

Symbols.	Treatments.		Analysis on Dry Basis.							
	Years with Super. 2 cwt. per year.	Years without Super.	N.	P.	Ca.	K.	N.	P.	Ca.	K.
			%	%	%	%	Lbs./ Acre.	Lbs./ Acre.	Lbs./ Acre.	Lbs./ Acre.
A	Before 1943	1943–47	1.93	.129	.82	1.25	76.33	5.12	32.38	37.9
B	1943	1944–47	2.18	.168	.88	1.10	88.16	6.78	35.52	34.0
C	1943–44	1945–47	2.10	.181	.84	1.25	93.75	8.05	37.21	41.9
D	1943–45	1946–47	2.11	.194	.77	1.14	97.2	8.94	35.42	40.3
E	1943–46	1947	2.12	.186	.88	1.16	107.24	9.30	44.52	49.2
F	1943–47	Nil	2.24	.210	.94	1.08	106.56	10.00	45.11	41.9

with the exception of potassium for which figures for the three years 1944-45 and 1947 only were obtained. In table 10 the weights for the various elements refer to the whole of the five year period. The yields of the treatments B, C, D, E and F compared with that from treatment A is given below in Table 11.

TABLE 11.

Treatment.	Years receiving Super.	Yield.	Increase over A.
		tons cwt.	cwt.
A	....	2 0	....
B	1943	2 1	1
C	1943–4	2 4.6	4.6
D	1943–4–5	2 5.4	5.4
E	1943–4–5–6	2 11.2	11.2
F	1943–4–5–6–7	2 8.6	8.6

An examination of the yields for each of the five years shows that the end of the 1943 Treatment (A) without super. was slightly but not significantly inferior to the other treatments.

In the next year, 1944 when treatment (A) had then been two years without superphosphate topdressing, its yields were significantly inferior to the others. On the other hand, the yield of Treatment (B) in this year, now one year without superphosphate, had not fallen significantly, but in the third season, notably inferior yields were recorded for both Treatments (A) and (B), for which superphosphate topdressing had now ceased for three and two years respectively. The yields from Treatment (C) now one year without superphosphate topdressing had not yet fallen greatly.

For the fourth year yields from Treatments (A) and (B) continued to fall while (C) now two years without superphosphate fell appreciably.

Graph 2 illustrates the tendency for yields to progressively decline with the passage of years with no superphosphate applications.

2. *Botanical Analyses.*

The percentage and yields of subterranean clover per acre are given in table 9. It will be noted that the percentage of clover decreased when superphosphate was not applied in one year. The depression on the proportion of clover became more acute when fertiliser was not used in more than two years.

3. *Chemical Analyses.*

The result of the chemical analyses of samples from each treatment together with the amounts of nitrogen, phosphorus, potassium and calcium taken up by the plants are given in table 10.

A drop in the phosphorus content of the pasture occurred when only one year's application of superphosphate was missed. The decline was accentuated with subsequent omission of topdressing. Where fertiliser was applied annually the percentage of phosphorus was .21 but on the plots which received no superphosphate for five years it fell to .129. The total uptake in the former case was 10 lb. and in the latter 5.12 lb. only. The rates of withdrawal of phosphorus showed a regular decrease according to the number of years in which the superphosphate topdressing had been omitted. It is of interest to record that the withdrawal of 10 lb. of phosphorus per acre is equivalent to the amount of this element in 99.5 lb. of 23 per cent. superphosphate.

The amount of nitrogen on the herbage also showed a decline when no fertiliser was applied for two years, and became more pronounced with the omission of topdressing in succeeding years.

The percentage of nitrogen however, did not show any significant variation except in the plots which received no superphosphate throughout the period of the experiment. The fall in the total weight of nitrogen was, therefore, related to bulk. It will be noted from table 9 that the percentage of clover decreased with the passage of years with no fertiliser. Whether this fact is related to the fall in the total nitrogen uptake cannot be demonstrated from the data although on general grounds it could be assumed that there was such a relationship.

There is no significant variation in the percentage of calcium although there is a fall in the total uptake as topdressing was omitted over a period of years. This again, in view of the maintenance of an even percentage can only be related to the decline in bulk. Details for potassium are also included. As indicated above analyses were made for this element for three years only. There was no significant variation.

DISCUSSION AND CONCLUSIONS.

During the war years many farmers enquired whether the reduced quantities of superphosphate which they could purchase would be better applied evenly over all their pastures annually, or at usual rates over a different portion of their property each year. While there was no experimental data available on which to base a conclusion, experience seemed to indicate that regular applications over all the pasture was preferable. There were many cases where after many years of annual topdressing farmers adopted the practice of topdressing part of their pasture only each year but observation has indicated that the practice was not successful. Results however were obscured somewhat by the general decline in pasture growth, following some years of reduced topdressing rates. This trial was designed to obtain some concrete data on the problem and the results tend to support the contention that regular annual applications are advisable.

The slight fall in yields following one year's omission of fertilizer should be considered, having in mind that annual topdressing of the experimental area had been the practice for many years. Had the paddock received no or only light applications over a number of years prior, the differences from the various treatments may have been more pronounced. However, there is support for annual topdressing although the effect of one year's omission in this experiment was not great. It would be an interesting subject for another trial to determine the effect of alternating topdressing and omissions.

In conditions similar to those at Wokalup it appears that best results will follow an annual application of superphosphate while the experiment described in Part 1 indicates that two cwt. is the optimum amount. Should circumstances recur, limiting the quantity of superphosphate available it can now be recommended with some experimental support that a reduction of the rate of application would be preferable to the omission of any portion of the pasture areas from the topdressing programme.

ACKNOWLEDGMENTS.

A number of officers of the Dairy and Irrigation Branches assisted in various ways with these experiments and grateful acknowledgment is made of their help.

STOCK FOODS.

Additional Stock Foods which have been registered at the Department of Agriculture under the Feeding Stuffs Act, 1928-48, for year 1949.

Stock Food.	Reg. No.	Brand.	By whom Registered.	Materials from which Made.	Registered Analysis.							
					Crude Protein.	Crude Fat.	Crude Fibre.	Sodium Chloride.	Phos. Acid (P_2O_5).	Lime.	Other.	
					% (Min.)	% (Max.)	% (Max.)	% (Max.)	%	% (Max.) Ca	%	%
A.—SIMPLE FOODS.												
1.—*Meat Meals.*												
Meat Meal	136	BROOME	Broome Freezing and Chilling Works	Meat and bone	60·0	10·0	10·0	....	11·0	....	....	....
Do.	143	MIDLAND	State Abattoirs (Midland Junction)	Meat Offal and waste	51·0	19·0	2·0	....	....	....	....	....
2.—*Meat and Bone Meals.*												
Meat and Bone Meal	132	ABERDEEN....	W. R. and N. N. Clarke	Meat and bone	48·0	15·0	2·0	....	....	....	....	....
Do. do.	133	S.M.P.	do. do. do.	do.	50·0	13·0	2·0	....	....	....	....	....
Fortified Protein Meal	137	IMPERIAL	W. Angliss & Co. (Aust.), Ltd.	Meat, bone, livers and animal offal	50·0	12·0	2·0	....	....	....	....	....
5.—*Milk Foods.*						(Min.)						
Dried Buttermilk	138	MAFFCO	W. R. and N. N. Clarke	Buttermilk dried	30·0	5·0	....	....	....	....	....	....
8.—*Liver Meals.*												
Liver Meal	142	IMPERIAL	W. Angliss & Co. (Aust.), Ltd.	Meat, bone, livers and animal offal	65·0	18·0	....	....	....	....	....	....
B.—COMPOUND FOODS.												
2.—*Cattle Foods.*											Max. Sulphur	
Cattle Food	140	EVELYN	Tropical Traders, Ltd.	Linseed meal, salt, limestone, chalk, animal charcoal, molasses, sulphur. minerals and medicinal herbs, pollard	5·0	3·0	5·5	13·0	3·7	9·5	3·6	....
4.—*Sheep Foods.*												
Sheep Food	141	do.	do. do.	do. do. do.	5·0	1·0	5·0	13·5	3·7	9·6	3·6	....
6.—*Chick Foods.*												
Chicken Meal	134	ROYAL SEAL	J. and W. Bateman Pty., Ltd.	Wheat, pannicum seed, peas, maize, shellgrit	10·0	2·0	4·0	....	....	....	....	....
7.—*Pig Foods.*												
Pig Food	139	EVELYN	Tropical Traders, Ltd.	Pollard, linseed meal, salt, limestone, chalk, sulphur, animal charcoal, minerals and medicinal herbs	5·0	1·0	5·0	9·75	3·5	9·5	4·5	....
C.—STOCK LICKS.												
2.—*Bone Meals.*									(Min.)	(Min.) CaO		
Bone Meal	135	WATTLE	Wattle Fertilizer Co.	Bones	16·0	....	....	....	22·5	30·0	....	
Sterilised Bone Grit Meal	144	NA	W. Thomas & Co. (W.A.), Ltd.	do.	20·0	8·0	1·0	0·2	20·0	10·0	....	

FURTHER NOTES ON PHOSPHORUS DEFICIENCY IN DAIRY COWS.

(See pp. 169 of this Journal,)

MUCH additional experience has now been obtained in the practical use of concentrated solutions of soluble phosphate prepared by mixing superphosphate with water. These solutions have been used to damp down the food given to milking cows in "test" herds and have quickly restored blood phosphorus levels to normal. Production has been particularly good where this supplement has been given a proper trial.

In quite a few cases, however, it has been found that farmers have been using phosphatic solutions which are far too weak to be of value. It is necessary to stress, therefore, that the superphosphate must be *thoroughly* mixed with the measured volume of water, before being left for the sludge to settle out.

Preparation of Saturated Solutions of Water-soluble Phosphate.

Superphosphate should be added to water at the rate of 5 lb. per gallon. Mix thoroughly with a stick and then pour from bucket to bucket about six times. Where the containers are too large to do this, stir thoroughly from top to bottom using a mixer made like a cream stirrer.

When all the water soluble phosphate has been dissolved further stirring is unnecessary. In practice, however, it may be an advantage to have two or three containers which can be used in rotation. If these are placed in a handy position it is not much bother to give them all a thorough stir several times a day.

On being left to stand, the undissolved material quickly settles to the bottom leaving a clear fluid which can be dipped off as required.

The sludge on the bottom should be thrown on the manure heap before the next batch is prepared.

Testing the Strength of Solutions.

The concentration of prepared phosphate solutions can be tested very simply by using an hydrometer as is used in testing car batteries. These cost about 12s. 6d. each. Solutions giving a reading of 1.100 or better are satisfactory.

With most batches of superphosphate the saturated solutions have a deep amber colour and this colour, when present, can be used as a guide to the concentration. After mixing pour some of the prepared solution into two clear glass pickle bottles. Then add a handful of superphosphate to one bottle, put in a cork, and shake thoroughly for ten minutes. Leave the two bottles side by side until the undissolved material has settled. If the extra superphopshate has increased the colour then the bulk solution is not full strength. The solutions *must* be full strength to give the required results. It should be remembered, however, that some batches of superphosphate do not give brown solutions in which case colour cannot be used as a guide.

Don't be misled by the fear that all this mixing is going to make a lot of work. In practice it does not—remember only half-a-pint of fluid is required per cow per day. But thorough mixing *is* essential for success and cannot be avoided. Perhaps the use of a concrete mixer, or some such device, would expedite matters considerably.

The Addition of Superphosphate to Drinking Water.

This promises to prove a very simple and efficient means of supplying phosphate to stock during the summer months. But it is a method which will quickly break down under careless or "rough and ready" control. It is important that the correct amounts of superphosphate should be added to the water. If too little is used, the stock will not get the desired phosphate. If too much, then the water will be made unpalatable.

As recorded in the foregoing article, it has been shown that, with training, cows will drink water containing 5 lb. of superphosphate per 100 gallons. This is the maximum amount which should be used and this will only be necessary under special conditions. In general practice 2 lb. of superphosphate per 100 gallons should give excellent results. This will not affect the palatability and will each day supply the dairy cow with as much phosphorus as is present in two to three ounces of bonemeal. This represents quite a worthwhile supplement and if available throughout the summer should do much to eliminate any danger of phosphorus deficiency. Where superphosphate is added to large drinking troughs according to the number of cattle using the trough, it is likewise probable that one pound of superphosphate per day for each four cows should be adequate.

It should be remembered that the idea of adding superphosphate to drinking water is a novel one and has yet to be proved in practice. So temper enthusiasm with discretion, make a thorough trial using no more than 2 lb. per 100 gallons. And don't "tip in a bit more, just for luck." The author would appreciate any comments from practical men concerning the results obtained from the use of superphosphate in this manner.

ERRATA.

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Page 103, paragraph four line one for "These figures seem to emphasise" substitute "These figures serve to emphasise."

Page 132, paragraph four for "£20, £12, £8 and £6" substitute "£10, £6, £4 and £3" respectively.

Page 164, under "Summary of Data" "Pigs Ratio cows to sows—All Zones" for "171:1" substitute 17.1:1.

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